

S
622.3424
L3spd
1985

DRAFT

STATE DOCUMENTS COLLECTION

DEC 24 1985

MONTANA STATE LIBRARY
1515 E. 6th AVE.
HELENA, MONTANA 59620

ENVIRONMENTAL IMPACT STATEMENT

PLEASE RETURN

**STILLWATER MINING COMPANY
STILLWATER PROJECT**

STILLWATER COUNTY, MONTANA

Montana Department of State Lands
U. S. Forest Service



Type of Statement: Draft Environmental Impact Statement

Lead Agencies:

State of Montana, Department of State Lands
U.S. Department of Agriculture, Forest Service

Proposed Action:

Approval of 1,000-ton-per-day platinum-palladium mining and milling project in the Stillwater Valley of southeastern Montana, proposed by Stillwater Mining Company.

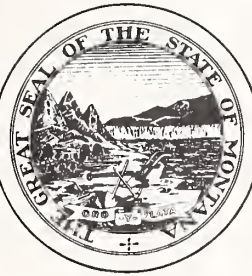
For additional information or copies of this EIS, please contact:

Kit Walther
Department of State Lands
Capitol Station
Helena, MT 59620 (406) 444-2074

Phillip Jaquith
U.S. Forest Service, Custer National Forest
Beartooth Ranger District
Box 3420
Red Lodge, MT 59068 (406) 446-2103

ml.
85-132
goc

DEPARTMENT OF STATE LANDS



TED SCHWINDEN, GOVERNOR

CAPITOL STATION

STATE OF MONTANA

(406) 444-2074

1625 ELEVENTH AVENUE
HELENA, MONTANA 59620

April 16, 1985

Dear Reader:

Enclosed for your review is a draft environmental impact statement (EIS) for Stillwater Mining Company's (SMC's) proposed platinum/palladium mine near Nye, Montana in Stillwater County.

The Montana Department of State Lands and U.S. Forest Service would like your comments.

The document analyzes the environmental impacts of SMC's proposed mine operation and reclamation plan and those of various alternatives. The alternatives analyzed include six production-system alternatives, one road-access alternative, and two power-supply alternatives.

Mailed comments must be post-marked by June 17, 1985. If comments or new information require major changes in the analysis a final EIS will be issued before a decision is made on the proposed mining and reclamation plan. The final EIS may incorporate portions of the draft EIS by reference, so please retain this copy for later use.

Send your comments to the attention of Mr. Kit Walther, Chief, Environmental Analysis Bureau, Montana Department of State Lands, Capitol Station, Helena, Montana 59620.

A public hearing will be held on May 15, 1985 at 7:00 p.m. in the Absarokee High School Gymnasium, Absarokee, Montana.

Additional information on SMC's application is available from the Department's Helena office and from the U.S. Forest Service, Supervisor's Office in Billings and Red Lodge District Rangers Office in Red Lodge.

A handwritten signature in cursive script, reading "Phillip Jaquith".

Phil Jaquith
District Ranger
U.S. Forest Service

A handwritten signature in cursive script, reading "Kit Walther".

Kit Walther, Chief
Environmental Analysis Bureau
Reclamation Division
Montana Department of State Lands



Digitized by the Internet Archive
in 2014

<https://archive.org/details/draftenvironment1985unit>

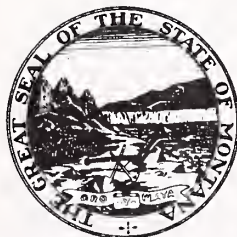
Draft

Environmental Impact Statement

STILLWATER PROJECT
STILLWATER COUNTY, MONTANA

April 1985

Montana Department of State Lands



A handwritten signature in cursive script, reading "Dennis Hemmer".

Dennis Hemmer, Commissioner

U.S. Forest Service, Custer National Forest



A handwritten signature in cursive script, reading "David Filius".

David Filius, Supervisor

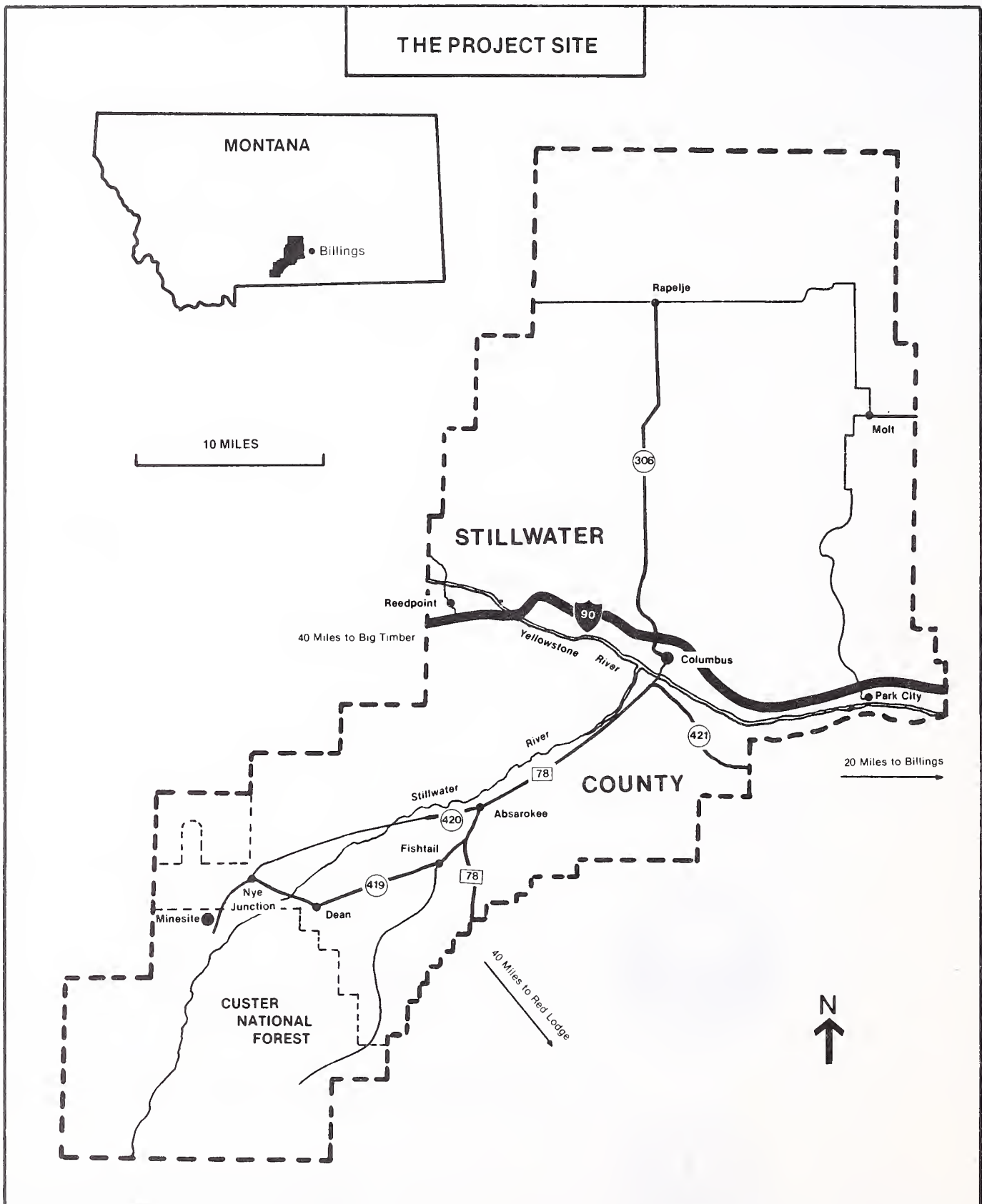


FIGURE S-1

The project site lies six miles south of Nye, in the southern part of Stillwater County. Just south of the minesite is the Absaroka-Beartooth Wilderness. Just east is the Stillwater River and the highway (FAS 419) that would serve the mine.

STILLWATER PROJECT

Action Under Consideration

Stillwater Mining Company proposes to open a platinum and palladium mine and mill in the Stillwater Valley of Stillwater County, Montana (fig. S-1). The project lies on both private and national forest system lands. The Commissioner of State Lands must decide whether to approve the permit as applied for by Stillwater Mining Company, deny the permit, approve the permit with modified mining or reclamation plans, or approve the permit subject to stipulations. The Supervisor of Custer National Forest must decide whether to approve the plan of operations as submitted, approve a revised plan of operations with changes incorporated, or disapprove the plan of operations.

The Company's Proposal

Stillwater Mining Company proposes to mine platinum and palladium from a steeply dipping mineralized zone lying within the Stillwater mineral complex. The company has begun exploration and, if its permit is approved, could begin full mine development. The project would last 30 years. The company would mine an average of 1,000 tons of ore per day by shrinkage stoping, an underground mining method. Ore would be milled next to the mine. Tailings from the milling process would be deposited next to the mill in a tailing pond. The project permit area covers 550 acres. Concentrate from the mill would be trucked to Columbus and shipped by rail to various markets.

Areas of Controversy

The main areas of controversy include water quality and quantity, reclamation, wildlife, aesthetic values, transportation, surface subsidence, socioeconomic effects, and scenic quality. (A full discussion of issues is contained in the introduction.)

Preferred Alternative

The agencies' preferred alternative consists of a 4-part package:

- (1) Production System: The agencies have chosen two acceptable production systems: the proposal and alternative 4. Alternative 4, considered by the agencies as environmentally superior, would require the company to slurry tailings from the mill, located at the minesite, to the tailing pond, located in Hertzler Valley. The agencies will select a single preferred production system in the final EIS after considering the public's comments on this draft.
- (2) Mine Portal Arrangement: The agencies prefer the proposed arrangement, which calls for 11 mountainside portals.
- (3) Access to the West Fork of the Stillwater River Trailhead: The agencies prefer the alternative that would require closing FR 846 through the minesite

and building a one-mile segment of new road between the Picket Pin Road and FR 846 in the West Fork of the Stillwater Valley.

(4) Power Supply: The preferred power supply alternative cannot be chosen until Montana Power Company submits an application for a Certificate of Need and Environmental Compatibility to the Montana Department of Natural Resources and Conservation.

Impacts of the Preferred Production Systems

Geology (Proposal): A landslide of the material above the Stillwater Mining Company's minesite, although considered of low probability, would significantly affect the area. Possible collapse of portions of the mine workings would present minimal long-term risk to the public. The height of the tailing dam and proximity to the Stillwater River presents the greatest potential for damage when compared with other alternatives.

Geology (Alternative 4): Impacts caused by a landslide at the minesite and from collapse of portions of the mine workings would be similar to those of the proposal. The dam height and distance of the impoundment to the Stillwater River would present a much lower potential for damage compared to the proposal.

Hydrology (Proposal): Mine development would have no greater impact on surface or ground water quality than has exploratory development. The mine would probably discharge about the same amount and quality of water as during exploration. Detectable, but insignificant, increases in nitrate and total nitrogen concentrations in alluvial ground water would continue downstream of the mine. Water quality of the Stillwater River would be unaffected.

Very high flood flows (greater than 1,000-year flood) could encroach on the tailing impoundment, contributing sediment to the Stillwater River. During such a flood, however, the sediment load would be so high from natural sources that the added mine-related sediment would be undetectable.

The proposed tailing impoundment would be located near the Stillwater River. Failure of the dam could introduce tailing water and solids into the river. An underdrain system in the dam would reduce the chance of such a dam failure.

Hydrology (Alternative 4): Seepage of water out of the percolation ponds would continue to increase nitrate and total nitrogen concentrations in the alluvium downstream of the mine. As with the proposal, the alluvial quality would be similar to what exists now, which meets drinking water standards.

The tailing pond would be located in a small drainage that flows into the Hertzler Valley, well away from the Stillwater River. Even extremely high flood flows or failure of the dam would not degrade the surface water quality of the Stillwater River, since the Hertzler Valley is relatively flat and porous.

Soils (Proposal): Impacts on soils would mainly stem from loss of soil organic matter and a reduction or loss of important soil microorganisms. Because of the loss of organic matter, postmining water- and nutrient-holding capacity would be low. This decreased capacity could result in lower vegetative density during the initial reclamation years. A loss of, or reduction in, soil microorganism populations caused by prolonged soil storage could result in lower species diversity and vigor for several years following initial revegetation.

Soils (Alternative 4): The soil impacts of alternative 4 would be the same as those for the proposal, assuming the company would propose a similar soil salvage and handling plan. However, the impacts caused by the loss of soil organic matter and the loss or reduction of soil microorganism populations would be more difficult to mitigate under this alternative. The company could not change its soil salvage and handling plans and salvage soils in two lifts under this alternative due to the large quantities of stones and boulders in the soils at the Hertzler site. Other, more intensive, mitigating measures would have to be implemented at this site.

Vegetation (Proposal): Mining would destroy 97 acres of vegetation and 68 acres of previously disturbed land. Most revegetation (73 percent) would occur after mine closure. Low nutrient- and water-holding capacity of topsoil may cause some revegetation failures. Seeded grasses would establish an erosion-controlling ground cover in most areas. Livestock forage production would increase, primarily due to revegetation of the 68 acres of previously disturbed lands. Plant diversity, however, would decline. Trees and shrubs would be reestablished, although at densities far below premining levels. Over the long term, tree and shrub densities and plant diversity would increase. Livestock forage production would slowly decline to near premining levels.

Vegetation (Alternative 4): Forty-nine acres of vegetation (mostly open-canopy forests) and 43 acres of previously disturbed lands would be destroyed at the minesite. The tailing pond would remove an additional 179 acres of vegetation (mostly stony grassland). The seven-mile slurry line would also disturb some vegetation. Most revegetation would occur after the mine closes. Assuming the general revegetation procedures at the tailing pond are similar to those used at the minesite, seeded grasses would form an erosion-controlling ground cover in most areas. Low nutrient- and water-holding capacity of topsoil may cause some revegetation failures. Stony soils at the tailing pond would create more difficulties. Despite some localized revegetation failures, livestock forage production would increase, primarily due to revegetation of previously disturbed lands. Plant diversity, however, would decline. Diversity would slowly increase and production would gradually decrease to near premining levels. Trees and shrubs, at densities far below premining levels, would be established at the minesite. Plans for tree and shrub planting at the tailing pond site have not been developed.

Aquatic Ecology (Proposal): Aquatic habitat and organisms would not be affected by the proposal.

Aquatic Ecology (Alternative 4): A slurry spill into the Stillwater River could occur, resulting in a temporary but sharp increase in total suspended

solids. Although the specific impacts to the aquatic biota are not known, the effects would be temporary, and most likely minor.

Fisheries (Proposal): Fish populations would not be directly affected by mining. However, population increases in the Stillwater Valley would lead to increased fishing pressure along the Stillwater and its tributaries, possibly leading to reduced fish populations or more conservative fishing regulations.

Fisheries (Alternative 4): Fish populations in the river would not be directly affected by mining. The slurry line over the West Fork of the Stillwater River would have the potential to rupture. However, the slurry line's design would minimize the chances of a spill. Even if a spill occurred, fish would probably not be adversely affected. Population increases in the Stillwater Valley would lead to increased fishing pressure, possibly resulting in reduced fish populations or more conservative fishing regulations.

Wildlife (Proposal): Mining would disturb only previously developed lands and other noncritical wildlife habitats. Reclaimed lands would eventually furnish adequate wildlife habitat. Mule deer of the Beartooth range and bighorn sheep would lose a small amount of wintering areas. These two species may also respond to mining activity and noises by withdrawing from areas nearby. The bighorn herd has some characteristics which may make it particularly vulnerable to nearby human activity. The Montana Department of Fish, Wildlife, and Parks (pers. com., August 5, 1982) believes that a herd reduction is imminent and that herd elimination is possible if mining is permitted. Further research would be required to confirm this position. Road kills of deer would increase due to mine-related traffic. Population increases in Stillwater County, of which only a portion would be caused by the mine, would increase housing construction, hunting and other recreation, and poaching by an unknown amount. The Montana Department of Fish, Wildlife, and Parks may respond to increased demand on the wildlife resources by establishing more conservative hunting regulations.

Wildlife (Alternative 4): Only previously developed lands and other noncritical wildlife habitats would be destroyed at the minesite. The tailing pond would remove primarily stony grasslands, an important mule deer habitat. Habitat destruction and activities at the minesite would displace some mule deer of the Beartooth winter range. The tailing pond, located in the high-density Limestone winter range, would displace still more deer. Loss of bighorn winter range would be minimal. Reclaimed lands would eventually furnish adequate wildlife habitat. The bighorn herd has some characteristics which may make it particularly vulnerable to nearby human activities. The Montana Department of Fish, Wildlife, and Parks (pers. com., August 5, 1982) believes that a herd reduction is imminent and that herd elimination is possible if mining is permitted. Further research would be required to confirm this position. Road kills of deer would increase due to mine-related traffic. Population increases in Stillwater County, of which only a portion would be caused by the mine, would increase housing construction, hunting and other recreation, and poaching by an unknown amount. The Montana Department of Fish, Wildlife, and Parks may respond to increased demand on wildlife resources by establishing more conservative hunting regulations.

Threatened and Endangered Species (Proposal): No threatened or endangered plants or animals would be affected by the project.

Threatened and Endangered Species (Alternative 4): No threatened or endangered plants or animals would be affected by this alternative.

Climate (Proposal): The small amount of particulate emitted from ground level sources during mining and milling would not affect the climate of the area.

Climate (Alternative 4): The climate would not be affected by the small amount of particulate emitted.

Air Quality (Proposal): Particulate matter would be the only pollutant emitted in significant quantities by activities associated with the proposed project. Even so, particulate emissions would be minor. Modeling results indicate that the annual average TSP (total suspended particulate) concentrations would increase by a maximum of $3 \mu\text{g}/\text{m}^3$ (micrograms per cubic meter) and 24-hour TSP concentrations would increase by a maximum of $16 \mu\text{g}/\text{m}^3$. Wind erosion of disturbed areas during construction activities would also be a potential, but temporary, source of particulate.

Air Quality (Alternative 4): The impacts of alternative 4 would be the same as those of the proposal.

Employment and Income (Proposal): The proposal would provide an additional 223 permanent jobs in Stillwater County, of which approximately 89 would be filled by local residents. Annual wages paid at the mine would range from \$14,500 to \$50,000.

Employment and Income (Alternative 4): The impacts of alternative 4 would be the same as those of the proposal.

Sociology (Proposal): The proposal would increase the population of Absarokee and Nye by as much as 25 percent. In turn, the number of mining jobs held by Absarokee residents would make up a large proportion of all jobs. Some current Absarokee residents would have less influence over community matters.

Population increases stemming from mine development would add an additional 510 persons to Stillwater County. These increases would amount 8.1 percent of the population projected for Stillwater County in 1990 without the Stillwater Project, and 7.8 percent in 1995. The population of Absarokee is projected to increase by 220 persons by 1995. This increase would amount to 24.7 percent rise above the 1995 level without the mine. The population of Columbus is projected to increase by 190 persons, a rise of 10.3 percent above the 1995 level without the mine.

Sociology (Alternative 4): The impacts of alternative 4 would be the same as those of the proposal.

Community Services (Proposal): Projected impacts to community services are based on the assumption that in-migrants will locate as described in Employment and Income. Stillwater County would need additional staff, as would the Sheriff's Department and Department of Social Services. Expansion of the

Absarokee sewer system, additional solid waste containers, expansion of the Columbus water system and sewer system, and an additional deputy in the Columbus Police Department would also be needed to accommodate increased population. Most area schools would need additional teaching staff and classrooms.

Community Services (Alternative 4): The impacts of alternative 4 would be the same as those of the proposal.

Fiscal Conditions (Proposal): The proposal would increase the assessed value of property in Stillwater County by \$4,396,382. The assessed value would indirectly rise another \$343,000, owing to the construction of residential and commercial property. The proposal would also produce annually \$419,441 in metalliferous mines license tax revenues and \$116,063 in resource indemnity trust tax revenues at full production, assuming current metal prices.

Fiscal Conditions (Alternative 4): Alternative 4 would increase the assessed value of property in Stillwater County by \$4,480,382. The indirect increase in property tax would amount to another \$343,000. Metalliferous mines license tax revenue collections would amount to \$419,441 annually. Alternative 4 would also produce \$116,063 in resource indemnity trust tax revenues.

Land Use (Proposal): The direct land use impacts of the project would be temporary and would not significantly affect land use patterns in the area. About 165 acres would be disturbed by the mine, mill, and tailing pond and as many as 41 acres of other lands could be permanently converted to residential uses. The proposed postmining land uses of wildlife habitat and recreation would be feasible; the reclaimed range condition would be better than it is now; however, the range condition would gradually decline to premining levels. Wildlife habitat reclamation would be generally successful.

Land Use (Alternative 4): Alternative 4 would temporarily displace agricultural production and other land uses on 256 acres. Such changes would not significantly alter land uses within Stillwater County. As much as 41 acres of land could be permanently converted to residential uses. Postmining land uses such as wildlife habitat and recreation would be feasible.

Transportation (Proposal): Travel related to the proposed mine would increase traffic volumes on FAS 419, FAS 420, and FAP 78 because of increases in work, household, and truck trips. FAS 419 and FAS 420 would be most affected by work traffic, FAP 78 by household trips. Increased traffic would result in increased vehicle accidents and road maintenance costs. Ranchers, recreation travelers, and wildlife could be adversely affected by the increased traffic.

Transportation (Alternative 4): The impacts of alternative 4 would be the same as those of the proposal.

Recreation (Proposal): The project would bring increased use to both the national forest and the private lands along the Stillwater River. This use could increase person-to-person contacts; put additional public pressure on the Forest Service to gain new public access routes to the Custer National Forest; increase harvest of fuel wood; and cause weekend crowding at campgrounds. Visual changes and noise from the mill would affect the recreational quality along FAS 419 and FR 846. In addition, traffic from shift changes would cause increased traffic hazards, particularly on Friday and Sunday afternoons, when recreation travel is heaviest.

Recreation (Alternative 4): The impacts of alternative 4 would be the same as those for the proposal.

Cultural Resources (Proposal): No cultural resource sites would be adversely affected directly by the project. Fourteen cultural sites, potentially eligible for the National Register of Historic Places, could be indirectly damaged by increased vandalism or relic collecting.

Cultural Resources (Alternative 4): With proper mitigating measures, no cultural resource sites would be directly damaged by alternative 4. Fourteen cultural sites, potentially eligible for the National Register of Historic Places, could be indirectly damaged by increased vandalism or relic collecting.

Aesthetics (Proposal): The mine and mill would alter the landscape, significantly affecting the visual resources at the minesite. The visual quality objectives based on mapping done by CDM (1980) would not be met, if at all, until some time after the completion of reclamation. The mine would be highly visible to travelers on FAS 419 and FR 846.

Noise levels near the milling complex would increase considerably. However, since the levels decrease rapidly with distance, travelers on FAS 419 would be exposed to only a small increase in noise levels. Noise levels would be higher on FR 846 through the mine-mill complex.

Aesthetics (Alternative 4): The mine in alternative 4 would have the same impact as in the proposal. The tailing impoundment would change the visual pattern of agricultural land until reclamation was completed. However, the impoundment would not be visible from FAS 419.

Noise levels near the milling complex would increase considerably. However, since the levels decrease rapidly with distance, travelers on FAS 419 would be exposed to only a small increase in noise levels. Noise levels on FR 846 would be similar to the proposal.

Impacts of the Preferred Mine Portal Arrangement

Proposal: The 11-adit surface proposal would result in decreased vegetative density during initial reclamation due to lowered water- and nutrient-holding capacity of disturbed soils. The new roads built to service adits could cause erosion and would be highly visible from the valley floor.

Impacts of the Preferred Road Access Alternative

Picket Pin Road Alternative: Reconstruction of an abandoned roadway would route traffic through elk winter range; however, impacts would be minor. Small increases in county road maintenance costs could occur. Traffic increases along FAS 140 may effect a historic peregrin falcon nesting site, although most traffic increases would not coincide with the early spring falcon nest selection period. Recreationists who use the Woodbine Campground

as a drop point would have to travel 9 miles further to reach the trailhead of the West Fork. Acquiring road access could be difficult because the land is privately owned.

Impacts of the Power Supply Alternatives

Power Corridor Alternative 1: Alternative 1 could cause slight increases in soil erosion due to construction of temporary roads and in sedimentation levels in streams due to channel crossings. Minor wildlife impacts would include: loss of 3 acres of white-tail deer habitat; loss of a small portion of waterfowl wetland habitat; and increased waterfowl deaths due to collision with the power line. Alternative 1 would also route the power line past a historic peregrin falcon nesting site. Potential exists for weed infestation along the corridor. Eleven cultural sites lie within the study area; possible impacts cannot be determined until MPC identifies specific centerlines. The power line would add approximately \$3 million to the property tax base of Stillwater County.

Power-line Corridor Alternative 2: Alternative 2 would have minor impacts to increased levels of sediment in streams and to increased soil erosion. The alternative would cause a negligible decrease in white-tail deer habitat and wetland habitat. Some electrocution of waterfowl could occur due to collision with the power line. Weed infestation could occur along the power-line route. Possible impacts to 10 cultural resource sites cannot be determined until specific centerlines are identified by MPC. The Stillwater County tax base would increase about \$3 million due to construction of the power line.

On-site Power Generation: On-site power generation would cause minor impacts to air quality, even with the addition of air pollution control devices. Noise levels would be increased 80 dB(A) within the immediate vicinity of the generator and would decrease to insignificant levels at a distance of 640 feet. The stack of the generator would be visible, but such visibility would contribute little to the overall visual impact of the project. On-site power generation would disturb an additional 2 acres within the permit area.

Introduction

The EIS.....	IN-1
Scope of the Analysis.....	IN-3
Previous Research.....	IN-5
Agency Responsibilities.....	IN-6
Montana Department of State Lands (DSL).....	IN-6
U.S. Forest Service.....	IN-6
U.S. Fish and Wildlife Service.....	IN-7
State Historic Preservation Office.....	IN-7
Montana Department of Health and Environmental Sciences...	IN-8
Air Quality Bureau.....	IN-8
Water Quality Bureau.....	IN-8
Hard Rock Mining Impact Board.....	IN-8
Stillwater County.....	IN-9
Army Corps of Engineers.....	IN-9
Local Conservation District.....	IN-9
Administrative Process.....	IN-9
Department of State Lands.....	IN-10
U.S. Forest Service.....	IN-10

Chapter I Comparing Alternatives, Selecting the Preferred Alternative

Production Systems.....	I-1
The Choices.....	I-1
The Preferred Production System Alternatives.....	I-4
Alternatives Rejected.....	I-9
Mine Portals.....	I-0
The Choices.....	I-10
The Preferred Mine Portal Alternative.....	I-12
Power Supply Alternatives.....	I-13
The Choices.....	I-13
The Preferred Power Supply Alternative.....	I-13
Road Access to the West Fork Stillwater River.....	I-13
The Choices.....	I-13
The Preferred Road Access Alternative.....	I-15
Development of Alternatives.....	I-18
Tailing Impoundment Siting.....	I-18
Mining Method.....	I-19
Transportation Methods.....	I-19
Mine Portal Arrangements.....	I-19
Utilities.....	I-19
Road Access to the West Fork of the Stillwater River.....	I-20

Chapter II Stillwater Project: Proposal and Alternatives

Stillwater Mining Company's Proposal.....	II-1
Ore Reserves and Ownership.....	II-1
Mining Plan.....	II-6
Milling the Ore.....	II-11
The Tailing Pond.....	II-11
Water Management.....	II-13
Utilities.....	II-13
Roads.....	II-14

Chapter II (continued)

Mine Employment.....	II-14
Bonding.....	II-14
Reclamation.....	II-15
Monitoring.....	II-17
Production System Alternatives.....	II-18
Production System Alternative 1.....	II-18
Production System Alternative 2.....	II-19
Production System Alternative 3.....	II-19
Production System Alternative 4.....	II-20
Production System Alternative 5.....	II-20
Production System Alternative 6.....	II-21
Cost Estimates of Production System Alternatives.....	II-21
Power Supply Alternatives.....	II-22
Power Corridor Alternative 1.....	II-23
Power Corridor Alternative 2.....	II-23
On-site Generation Alternative 3.....	II-23
Mine Portal Alternatives.....	II-24
Mine Portal Alternative 1.....	II-24
Mine Portal Alternative 2.....	II-24
Capital Costs of Mine Portal Alternatives.....	II-24
Alternative Routes to the West Fork of the Stillwater River....	II-25
Stillwater Mining Company's Proposal.....	II-25
West Fork Road Alternative.....	II-25

Chapter III Description of Affected Environment

Geology.....	III-1
General Geology--Stillwater Complex.....	III-1
Historical Mining in the Stillwater Complex.....	III-3
Chromite.....	III-3
Copper and Nickel.....	III-3
Platinum-group Metals.....	III-3
General Geology of the Minesite (Proposal and	
Alternative 1).....	III-4
Topography and Geomorphology.....	III-4
Surficial Geology.....	III-4
Bedrock Geology.....	III-6
Structural Geology.....	III-6
Geologic Hazards.....	III-6
Geology of the Stratton Ranch Site (Alternatives 2 & 3)...	III-10
Geology of the Hertzler Valley Site (Alternatives	
4, 5, and 6).....	III-10
Surficial Geology.....	III-10
Bedrock Geology.....	III-11
Geologic Hazards.....	III-11
Hydrology.....	III-11
Surface Water.....	III-11
Stillwater River.....	III-11
Tributaries of the Stillwater River.....	III-14
Minesite (Proposal and Alternative 1).....	III-15
Stratton Ranch Site (Alternatives 2 and 3).....	III-16
Hertzler Valley Site (Alternatives 4, 5, and 6).....	III-16

Chapter III (continued)

Ground Water.....	III-17
Minesite (Proposal and Alternative 1).....	III-17
Stratton Ranch (Alternatives 2 & 3).....	III-23
Hertzler Valley Site (Alternatives 4, 5, and 6).....	III-23
Soils.....	III-25
Overview.....	III-25
Soils of the Proposed Permit Area (Including Alternative 1).....	III-26
Stratton Site Soils (Alternatives 2 and 3).....	III-28
Hertzler Site Soils (Alternatives 4, 5, and 6).....	III-28
Prime Farmlands.....	III-28
Vegetation.....	III-28
Vegetation Type Descriptions.....	III-28
National Forest Timber Resources.....	III-35
Noxious Weeds.....	III-35
Aquatic Ecology.....	III-35
Aquatic Invertebrates.....	III-37
Periphyton.....	III-37
Fisheries.....	III-38
Stillwater River.....	III-38
West Fork of the Stillwater River.....	III-40
Wildlife.....	III-40
Big Game Species.....	III-41
Mule Deer.....	III-41
White-tailed Deer.....	III-46
Bighorn Sheep.....	III-47
Elk.....	III-52
Other Big Game Species.....	III-52
Small and Medium-Sized Mammals.....	III-52
Raptors (Birds of Prey).....	III-53
Songbirds.....	III-54
Gamebirds and Waterfowl.....	III-54
Reptiles and Amphibians.....	III-54
Threatened and Endangered Species.....	III-54
Plant Species.....	III-54
Animal Species.....	III-54
Climate.....	III-55
Precipitation.....	III-55
Temperature.....	III-57
Winds.....	III-57
Air Quality.....	III-57
Employment and Income.....	III-59
Employment.....	III-59
Income.....	III-64
Sociology.....	III-64
The Study Area.....	III-64
Methodology.....	III-66
Demography.....	III-66
Occupational Structure.....	III-67
Values.....	III-67
Attitudes and Concerns.....	III-68

Chapter III (continued)

Community Services.....	III-69
Schools.....	III-69
Columbus.....	III-69
Absarokee.....	III-70
Nye and Fishtail.....	III-70
Solid Waste.....	III-70
Law Enforcement.....	III-70
Columbus City Police.....	III-71
Water Supply.....	III-71
Sewer System.....	III-71
Fire Protection.....	III-72
City Shop.....	III-72
Ambulance.....	III-73
Hospital and Medical Personnel.....	III-73
Fiscal Conditions.....	III-73
Stillwater County.....	III-73
Schools.....	III-74
Tax Base.....	III-74
Land Use.....	III-74
Proposed Permit Area and Surroundings.....	III-74
Current and Previous Trends.....	III-76
Range Condition and Stocking Rate.....	III-77
Transportation.....	III-77
Federal Aid Secondary 419.....	III-77
Bridges.....	III-78
Federal Aid Secondary 420.....	III-78
Federal Aid Primary 78.....	III-79
Recreation.....	III-79
National Forest Recreation.....	III-79
Recreation Outside the National Forest.....	III-84
Community Recreation Resources.....	III-86
Cultural Resources.....	III-86
Aesthetics.....	III-87
Visual Resources.....	III-87
Foothill Subcharacter Type.....	III-87
Mountainous Subcharacter Type.....	III-90
Noise.....	III-91

Chapter IV Impacts of the Proposal and Alternatives: Production Systems

Geology.....	IV-1
Impacts All Production Systems Have in Common.....	IV-1
Removal of Ore.....	IV-1
Geologic Hazards.....	IV-1
Other Mineral Resources.....	IV-5
Blasting.....	IV-5
Mitigating Measures.....	IV-5
Impacts Unique to the Proposal.....	IV-6
Geomorphology.....	IV-6
Tailing Site.....	IV-7
Impacts Unique to Alternative 1.....	IV-7
Impacts Unique to Alternative 2.....	IV-8

Chapter IV (continued)

Impacts Unique to Alternative 3.....	IV-8
Impacts Unique to Alternative 4.....	IV-9
Mitigating Measures.....	IV-9
Impacts Unique to Alternative 5.....	IV-9
Impacts Unique to Alternative 6.....	IV-9
Hydrology.....	IV-10
Impacts All Production Systems Have in Common.....	IV-10
Mitigating Measure.....	IV-11
Impacts Unique to the Proposal.....	IV-12
Impacts Unique to Alternative 1.....	IV-13
Impacts Unique to Alternative 2.....	IV-13
Impacts Unique to Alternative 3.....	IV-13
Impacts Unique to Alternative 4 and 6.....	IV-13
Impacts Unique to Alternative 5.....	IV-14
Soils.....	IV-14
Impacts All Production Systems Have in Common.....	IV-15
Soil Quantity and Quality.....	IV-15
Biological Soil Impacts.....	IV-16
Unavoidable Soil Impacts.....	IV-17
Impacts Unique to the Proposal and Alternatives	
1, 2, and 3.....	IV-17
Impacts Unique to Alternatives 4, 5, and 6.....	IV-18
Vegetation.....	IV-20
Impacts All Production Systems Have in Common.....	IV-21
General Procedures for Revegetation.....	IV-21
Seeding--Herbaceous Species.....	IV-22
Woody Species.....	IV-24
Noxious Weeds.....	IV-24
Mitigating Measures.....	IV-25
Impacts Unique to the Proposal.....	IV-26
Impacts Unique to Alternative 1.....	IV-26
Impacts Unique to Alternative 2.....	IV-27
Impacts Unique to Alternative 3.....	IV-28
Impacts Unique to Alternative 4.....	IV-28
Impacts Unique to Alternative 5.....	IV-28
Impacts Unique to Alternative 6.....	IV-28
Aquatic Ecology.....	IV-28
Impacts Unique to the Proposal and Alternatives	
1, 2, 3, and 5.....	IV-29
Impacts Unique to Alternatives 4 and 6.....	IV-29
Fisheries.....	IV-29
Impacts Unique to the Proposal and Alternatives	
1, 2, 3, and 5.....	IV-29
Mitigating Measures.....	IV-29
Impacts Unique to Alternatives 4 and 6.....	IV-30
Mitigating Measures.....	IV-30
Wildlife.....	IV-30
Impacts All Production Systems Have in Common.....	IV-31
Direct Impacts.....	IV-32
Indirect Impacts.....	IV-36
Mitigating Measures.....	IV-39

Chapter IV (continued)

Impacts Unique to the Proposal.....	IV-40
Impacts Unique to Alternative 1.....	IV-40
Impacts Unique to Alternative 2.....	IV-40
Impacts Unique to Alternative 3.....	IV-41
Impacts Unique to Alternative 4.....	IV-41
Mitigating Measure.....	IV-41
Impacts Unique to Alternative 5.....	IV-41
Mitigating Measure.....	IV-41
Impacts Unique to Alternative 6.....	IV-42
Mitigating Measure.....	IV-42
Threatened and Endangered Species.....	IV-42
Impacts All Production Systems Have in Common.....	IV-42
Mitigating Measures.....	IV-42
Impacts Unique to the Proposal and Alternative 1.....	IV-43
Mitigating Measures.....	IV-43
Impacts Unique to Alternatives 2 and 3.....	IV-43
Mitigating Measures.....	IV-43
Impacts Unique to Alternatives 4 and 6.....	IV-43
Mitigating Measure.....	IV-43
Impacts Unique to Alternatives 5.....	IV-44
Mitigating Measures.....	IV-44
Climate.....	IV-44
Air Quality.....	IV-44
Impacts All Production Systems Have in Common.....	IV-45
Impacts Unique to the Proposal and Alternatives	
1, 2, 3, 4, and 6.....	IV-46
Impacts Unique to Alternative 5.....	IV-46
Mitigating Measures.....	IV-46
Employment and Income.....	IV-47
Employment.....	IV-47
Income.....	IV-49
Impacts of Extended Mine Life.....	IV-49
Sociology.....	IV-49
Impacts All Alternatives Have in Common.....	IV-50
Demography.....	IV-50
Values.....	IV-51
Housing.....	IV-51
Project Concerns.....	IV-53
Mine Closure.....	IV-54
Mitigating Measures.....	IV-54
Impacts Unique to the Proposal and Alternatives	
1, 2, 3, 4, and 6.....	IV-55
Impacts Unique to Alternative 5.....	IV-55
Community Services.....	IV-55
Stillwater County.....	IV-55
County Administration.....	IV-56
Law Enforcement.....	IV-56
Social Services.....	IV-56
Other Services.....	IV-56
Solid Waste Collection.....	IV-56
Sewer System.....	IV-57
Absarokee Water Users Association.....	IV-57

Chapter IV (continued)

Town of Columbus.....	IV-57
Law Enforcement.....	IV-57
Street Maintenance.....	IV-57
Water and Sewer System.....	IV-57
Schools.....	IV-58
The Effects of Mine Closure.....	IV-59
Mitigating Measures.....	IV-59
Fiscal Conditions.....	IV-60
Impacts All Production Systems Have in Common.....	IV-61
Property Tax Base.....	IV-61
Metalliferous Mines License Tax.....	IV-62
Resource Indemnity Trust Tax.....	IV-62
Impacts Unique to Alternatives 1 and 5.....	IV-62
Impacts Unique to Alternatives, 2, 3, 4, and 6.....	IV-62
Mine Closure.....	IV-62
Land Use.....	IV-63
Impacts All Production Systems Have in Common.....	IV-63
Impacts Unique to the Proposal.....	IV-64
Impacts Unique to Alternative 1.....	IV-64
Impacts Unique to Alternative 2.....	IV-65
Impacts Unique to Alternative 3.....	IV-65
Impacts Unique to Alternative 4.....	IV-65
Impacts Unique to Alternative 5.....	IV-65
Impacts Unique to Alternative 6.....	IV-65
Transportation.....	IV-65
Impacts All Production Systems Have in Common.....	IV-65
FAS 419.....	IV-65
FAS 420.....	IV-66
FAP 78.....	IV-66
Bridges.....	IV-68
U.S. Forest Service Road 846.....	IV-68
Mitigating Measures.....	IV-68
Impacts Unique to the Proposal.....	IV-69
Mitigating Measures.....	IV-69
Impacts Unique to the Alternatives 1, 2, 3, 4, and 6.....	IV-69
Impacts Unique to Alternative 5.....	IV-70
Mitigating Measures.....	IV-70
Recreation.....	IV-70
Impacts All Production Systems Have in Common.....	IV-70
National Forest and Wilderness Recreation Resources..	IV-70
Recreation Resources Outside Custer National Forest..	IV-71
Mitigating Measures.....	IV-72
Impacts Unique to the Proposal and Alternatives	
1, 2, 3, 4, and 6.....	IV-72
Impacts Unique to Alternative 5.....	IV-72
Cultural Resources.....	IV-73
Impacts All Production Systems Have in Common.....	IV-73
Mitigating Measures.....	IV-74
Impacts Unique to the Proposal and Alternatives	
1, 2, 3, 4, and 6.....	IV-75

Chapter IV (continued)

Impacts Unique to Alternative 5.....	IV-75
Mitigating Measures.....	IV-75
Aesthetics.....	IV-75
Impacts All Production Systems Have in Common.....	IV-76
Landscape.....	IV-76
Noise.....	IV-76
Mitigating Measures.....	IV-76
Visual.....	IV-76
Noise.....	IV-77
Impacts Unique to the Proposal.....	IV-77
Impacts Unique to Alternative 1.....	IV-79
Impacts Unique to Alternative 2.....	IV-79
Impacts Unique to Alternative 3.....	IV-79
Impacts Unique to Alternative 4.....	IV-79
Impacts Unique to Alternative 5.....	IV-79
Impacts Unique to Alternative 6.....	IV-80
Irreversible and Irretrievable Commitments of Resources	
Short-term Uses Versus Long-term Productivity of the	
Land Affected by Mining.....	IV-80

Chapter V Impacts of the Proposal and Alternatives:

- Mine Portal Arrangements	
- Power Alternatives	
- West Fork of the Stillwater Road Accesses	
Mine Portal Arrangements.....	V-1
Proposed Portal Arrangement.....	V-1
Mitigating Measures.....	V-2
Portal Arrangement Alternative 1.....	V-3
Portal Arrangement Alternative 2.....	V-3
Power Alternatives.....	V-3
Power Corridor Alternative 1.....	V-4
Power Corridor Alternative 2.....	V-6
On-site Generation--Alternative 3.....	V-7
West Fork of the Stillwater Road Access.....	V-7
Proposed Access Route.....	V-7
Mitigating Measures.....	V-8
Picket Pin Road Alternative.....	V-8

Chapter VI Appendixes

Appendix A: Tailing Pond Siting Study.....	VI-2
Appendix B: Flotation Reagents Used in the Tailing Process....	VI-10
Appendix C: Crown Pillar Stability.....	VI-14
Appendix D: Visual Resources System.....	VI-17
Appendix E: Common and Scientific Names of Plant Species.....	VI-19
Appendix F: Common and Scientific Names of Fish.....	VI-21
Appendix G: Common and Scientific Names of Wildlife Species...	VI-22

Chapter VII

Literature Cited.....	VII-1
-----------------------	-------

Chapter VIII Consultation and Coordination

Research and Writing.....	VIII-1
Review.....	VIII-2
People, Agencies, and Companies Consulted.....	VIII-2
Review of This Statement.....	VIII-3

LIST OF FIGURES

Summary

S-1--Location of the Project Area.....	ii
--	----

Introduction

IN-1--Artist's View of Stillwater Valley.....	IN-2
---	------

Chapter I

I-1--Production System Alternatives.....	I-3
I-2--Mine Portal Arrangements.....	I-11
I-3--Power-line Routes.....	I-14
I-4--Alternative Access to the West Fork of the Stillwater River.....	I-16

Chapter II

II-1--Stillwater Project Permit Area.....	II-2
II-2--Proposed Project Pland.....	II-3
II-3--Land Ownership.....	II-4
II-4--Mineral Ownership of the Stillwater Complex.....	II-5
II-5--Underground Workings.....	II-7
II-6--Shrinkage Stope.....	II-8
II-7--Facilities and Tailing Dam.....	II-10
II-8--Tailing Impoundment Cross-Section.....	II-12
II-9--Postmining Topography of Tailing Impoundment.....	II-16

Chapter III

III- 1--Geology of the Stillwater Complex.....	III-2
III- 2--Topography of Upper Stillwater Valley.....	III-5
III- 3--Geology of the Minesite.....	III-7
III- 4--Water Monitoring Sites.....	III-19
III- 5--Geology of the Stillwater Valley.....	III-27
III- 6--Wildlife and Vegetation Study Area.....	III-29
III- 7--Vegetation Types.....	III-30
III- 8--Aquatic Sampling Stations.....	III-36
III- 9--Percent of Spawning-Size Rainbow Trout Samples Per Section.....	III-39
III-10--Montana Department of Fish, Wildlife, and Parks Study Area.....	III-41
III-11--Habitat Types.....	III-43
III-12--Mule and White-tailed Deer Winter Ranges.....	III-45
III-13--Elk and Bighorn Sheep Winter Ranges.....	III-49
III-14--Temperature, Precipitation, and Effective Precipitation at Red Lodge, Montana.....	III-56
III-15--Wind Speeds at the Hertzler Site.....	III-58

Chapter III (continued)

III-16--Wind Speeds at the Minesite.....	III-58
III-17--Monthly Mean Total Suspended Particulate Concentrations.....	III-61
III-18--Land Uses in the Stillwater Project Area.....	III-75
III-19--National Forest Lands and Recreation Sites in Area Surrounding the Project.....	III-80

Chapter IV

IV-1--Stillwater Project Employment Schedule.....	IV-48
IV-2--Stillwater Project Population Projections.....	IV-52
IV-3--Photographic Interpretation of the Stillwater Project.....	IV-78

Appendix

A-1--Tailing Sites Considered.....	VI-3
------------------------------------	------

LIST OF TABLES

Chapter I

I-1--Major Components of Proposed and Alternative Production Systems.....	I-2
I-2--Stillwater Project Summary of Impacts with Indication of Mitigation.....	I-6
I-3--Summary of Impacts from Mine Portals.....	I-12
I-4--Summary of Impacts from Power Alternatives.....	I-15
I-5--Summary of Impacts for West Fork Access.....	I-17

Chapter II

II-1--Surface Area Disturbance.....	II-2
II-2--Present Value of Cost Estimates for Stillwater Project Alternatives.....	II-22
II-3--Comparison of Capital Costs for Surface Disturbance Alternatives.....	II-25

Chapter III

III-1--Ammonia, Nitrate, and Phosphorus Concentrations in Ground Water.....	III-22
III-2--Vegetation Types in the Stillwater Study Area.....	III-31
III-3--Characteristics of Vegetation Types on the Stillwater Study Area.....	III-32
III-4--Wildlife Habitat Types and Corresponding Vegetation Types in the CDM Wildlife Study Area.....	III-42
III-5--Mule Deer Population Estimates by Helicopter Survey Unit, MDFWP Study Area.....	III-44
III-6--Post-Hunting Season Counts of the Stillwater Bighorn Population.....	III-48
III-7--Home Range Sizes for Four Bighorn Ewes During Winter....	III-51
III-8--Habitat Use by Bighorn During Winter.....	III-51
III-9--Observed and Expected Numbers of Common Small Mammals Trapped in the Stillwater Study Area.....	III-53

Chapter III (continued)

III-10--Size of Largest Storm That Can be Expected at the Project Area During Various Lengths of Time.....	III-57
III-11--Ambient Air Quality Standards (AAQS).....	III-60
III-12--Employment by Major Industry in Stillwater County.....	III-62
III-13--Stillwater County Employment Statistics.....	III-63
III-14--Stillwater County Personal Income by Major Source.....	III-65
III-15--Stocking Rates for Areas That Would be Disturbed by Alternatives.....	III-76
III-16--Developed Campgrounds and Picnic Areas.....	III-81
III-17--Developed Trailheads and Constructed Parking Areas.....	III-81
III-18--Occupancy Spots on Public Roads--Number and Capacity...	III-82
III-19--Campground Use--Average Number of Units Occupied by Month and Year.....	III-83
III-20--Average Daily Trail Use.....	III-83
III-21--Recreation Demand Trends for the Beartooth Planning Unit.....	III-85
III-22--Wilderness Visitor Capacity.....	III-85
III-23--Cultural Resource Sites Potentially Eligible for Listing in the National Register of Historic Places....	III-88
III-24--Historic Sites Potentially Eligible for Listing in the National Register of Historic Places.....	III-89

Chapter IV

IV- 1--Soil Resources of the Proposed Disturbance Area.....	IV-18
IV- 2--Proposed Seeding Mixtures for Revegetation.....	IV-23
IV- 3--Planting Rates and Estimated Mortality Rates of Trees and Shrubs Planted During Revegetation.....	IV-25
IV- 4--Proposed Revegetation Schedule and Revegetation Species Category.....	IV-27
IV- 5--Wildlife Habitat Types Present in Proposed and Alternative Disturbance Areas.....	IV-33
IV- 6--Inventory of Emission Sources.....	IV-45
IV- 7--Population Projections With and Without the Stillwater Project.....	IV-51
IV- 8--Expected Distribution of Persons Moving into Stillwater County.....	IV-51
IV- 9--Montana School Accreditation Standards.....	IV-58
IV-10--Annual Production and Gross Value of Minerals.....	IV-61
IV-11--Taxable Value of Slurry Lines Under Alternatives 2, 3, 4, and 6.....	IV-63
IV-12--Acres of Rangeland Disturbed Under Each Alternative and Livestock Production Foregone.....	IV-64
IV-13--Current and Projected Traffic.....	IV-67
IV-14--Major Sources and Estimated Noise Levels.....	IV-77

Chapter V

V-1--Average Miles of Land Use/Cover Crossed.....	V-6
---	-----

Appendix

A-1--Sites Considered.....	VI-2
A-2--Summary of Step 2: Final Ratings.....	VI-6
B-1--Estimated Concentrations of Reagents in the Tailing Pond..	VI-11
D-1--Existing Visual Condition Definitions.....	VI-18

THE EIS: WHY IT IS WRITTEN
WHO TAKES PART
WHAT DECISIONS MUST BE MADE

Stillwater Mining Company is proposing to construct a platinum-palladium mine and mill in the Stillwater River Valley of Stillwater County, Montana (fig. IN-1). The Montana Department of State Lands and U.S. Forest Service have determined that the project "may significantly affect the quality of the human environment." As a result, the two agencies are required to prepare an environmental impact statement (Montana Environmental Policy Act [MEPA], 1971, and National Environmental Policy Act [NEPA], 1969).

The Department of State Lands and the Forest Service issued a draft environmental impact statement (EIS) in June 1982 on a similar project proposed by the Anaconda Minerals Company. Work on that EIS was suspended in 1983, when Anaconda signed a joint venture agreement with Chevron USA and Manville Products Company. The June 1983 agreement established a partnership called Stillwater Mining Company and named Chevron USA as the project operator.

Stillwater Mining Company has revised the plan submitted by Anaconda. The changes are significant enough that the 1982 EIS has been abandoned and this new document has been written.

THE EIS

The National and Montana Environmental Policy Acts require the Forest Service and Montana Department of State Lands to go through the same steps:

- (1) Issue a draft EIS
- (2) Encourage and accept public comments on the draft.
- (3) Issue a final EIS. In accordance with rules adopted by DSL and Council on Environmental Quality regulations, the final EIS may--
 - (a) Modify alternatives, including the proposed action.
 - (b) Develop and evaluate alternatives not previously given serious consideration.
 - (c) Supplement, improve, or modify the analysis contained in the draft.
 - (d) Make factual corrections.
 - (e) Explain why comments do not warrant further response.

The EIS analyzes (1) the company's proposal, (2) the lands, people, and resources the proposal would affect, and (3) the consequences (or impacts) of the proposal. The draft EIS does not present the Department's or the Forest Service's decision, but does present the alternative the agencies prefer.

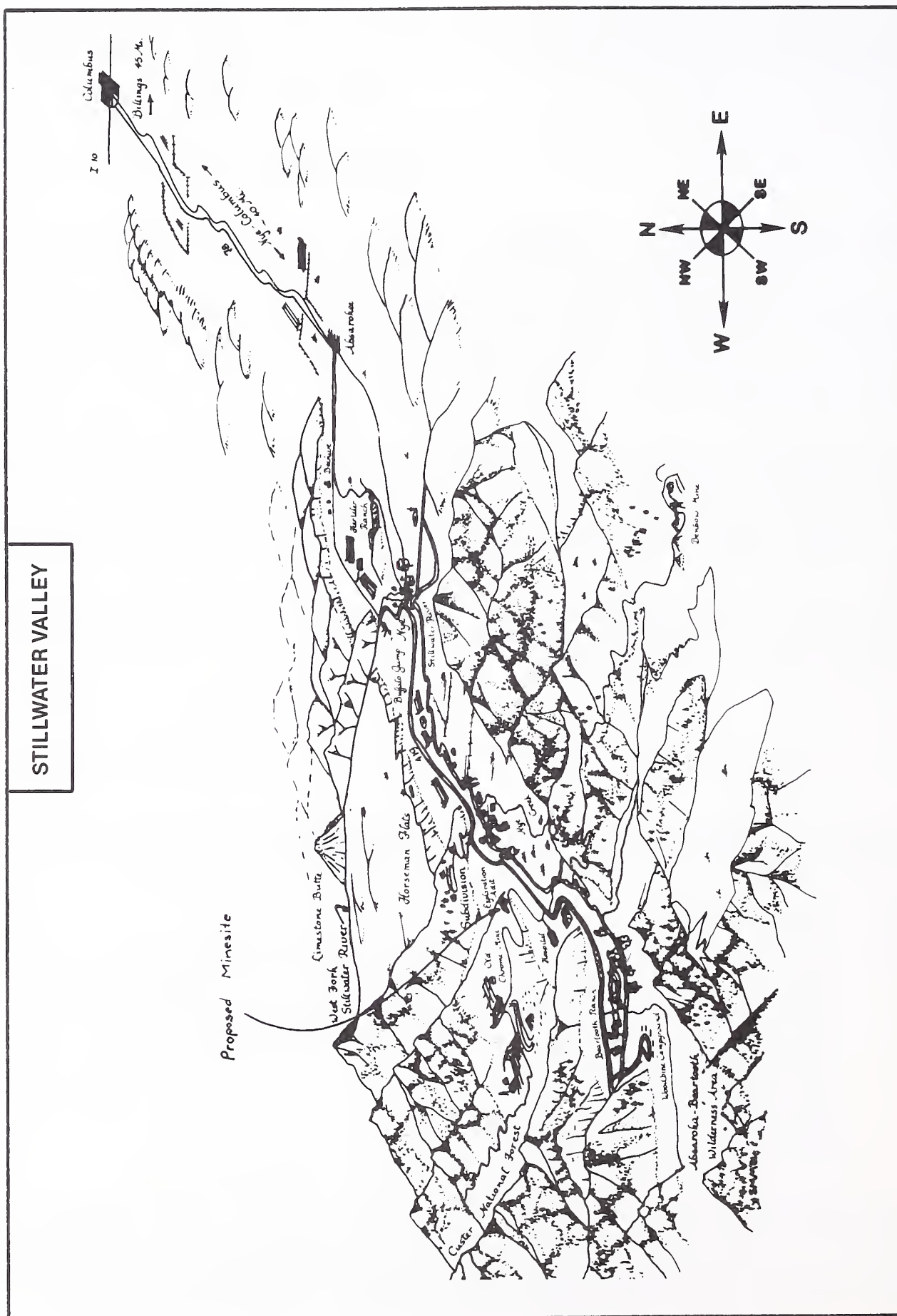


FIGURE IN-1

The mountainous southern part of Stillwater County gives way in the north to rolling hills and plains. Three towns along the Stillwater River--Nye, Absarokee, and Columbus--would be affected by the project.

The agencies will make a decision on Stillwater Mining Company's proposal after publication of the final EIS. The Department can make a decision no sooner than 15 days following publication. The Forest Service can make a decision upon publication. The Forest Service's decision will be contained in a decision notice enclosed with the final document.

SCOPE OF THE ANALYSIS

Since starting the analysis on the Stillwater project in 1981, the Department of State Lands and the U.S. Forest Service have formally received comments from the public at three separate times. The concerns expressed in the comments, along with the concerns of the Department and the Forest Service, have formed the scope of the EIS analysis.

The first time the public voiced their concerns over the project was in September 1981 at two "scoping" meetings, which 130 people attended. Comments were received at the same time by mail, in response to a Forest Service mailing of 500 questionnaires. Eighty people returned questionnaires. The Forest Service compiled the results from the meetings and questionnaires and mailed them to the 194 people who had requested them. (The 1981 scoping results are still available from Custer National Forest, Billings and Red Lodge.)

The next time the public spoke out about the project was after the original draft EIS was published in June 1982. The agencies received 32 letters and took testimony at a public meeting from 14 people. (The letters are available for review at the Department of State Lands, Helena.)

The third and most recent time comments were received was at a meeting following Stillwater Mining Company's filing of a new plan of operations with the Department of State Lands and the Forest Service. In the April 1984 meeting, held in Absarokee, 12 people spoke (about 90 attended). Afterwards, the agencies received letters from eight people. (Meeting transcripts, letters, and scoping results can be reviewed at the Department of State Lands, Helena, or the U.S. Forest Service, Billings or Red Lodge.)

All concerns raised since the 1981 meetings have guided the collection of data for the project and the analysis contained in this EIS. A summary of the major concerns follows:

(1) Water quality and quantity. Would tailings or mine water contaminate surface or ground water? Would the project affect nearby springs, wells, or the Stillwater River? Would water quality around the project be monitored? How? For how long? What steps would be taken if the monitoring shows the project is polluting surrounding waters? Would the percolation ponds work?

(2) Community services. Would direct or indirect population growth associated with the project adversely affect area roads, schools, law enforcement, sewer and water systems, solid waste collection, or similar community facilities or services? Would such community development and the need for housing financially burden "existing residents"?

IN-4 / Introduction

(3) Reclamation. Would the company successfully reclaim the areas disturbed? What would the company do to overcome the problems posed by thin soils and high elevations? Could introduction of weeds during revegetation be avoided? How would reclamation success be judged? How long would the company monitor reclamation? How long would the reclamation bond be held? Would the tailing impoundment be stable and resist erosion?

(4) Fisheries and aquatic ecology. Would the project result in decreased sport fishing opportunities, fish populations, and increased fishery management needs? Would the project affect aquatic life? Would aquatic invertebrate populations be monitored?

(5) Recreation. Would the project reduce recreational opportunities, lower the quality of recreational experiences, or conflict with recreation traffic?

(6) Air quality. Would the project emit air pollutants? How much dust would there be?

(7) Wildlife. Would the project directly or indirectly disrupt wildlife populations, including mule deer, elk, bighorn sheep, and the two endangered species found in the project area--the bald eagle and peregrine falcon? Would measures be taken to prevent roadkills? Would wildlife populations be monitored?

(8) Wilderness. Would population growth affect wilderness recreation?

(9) Life style. Would the project affect the rural life style in the area?

(10) Land use. Would the project result in a change in the use of lands from agricultural to residential uses, particularly near existing towns? Would land values appreciate? How would agriculture be affected? Would the company control the spread of noxious weeds?

(11) Aesthetic values. How would the project affect scenic quality? Would the project buildings be placed to keep scenic deterioration to a minimum? How much noise would the operation make?

(12) Mining methods. Are there any other ways of mining, such as cut-and-fill stoping, that would reduce mine impacts?

(13) Subsidence. Would the ground above the mine subside? What would the company do to prevent or repair surface holes or depressions?

(14) Alternatives. Has the company explored all alternative transportation and mining methods? What about different tailing pond sites? How do the costs of each alternative compare?

(15) Power. How large a power line would the project require? Where would it be placed? What impacts would it have? What affects would power lines within the permit area have?

(16) Transportation. What would happen to the condition of nearby roads and highways? How much would traffic increase? Would road safety decline? Would

the company bus workers to the mine? How would traffic affect ranching operations that use FAS 419? What about impacts on FAS 420? How would residents along these roads be affected?

(17) Income. Would high-wage mine jobs raise the local cost of living, especially the cost of housing?

(18) Employment. What would happen to people moving to the area to find work at the mine who, in fact, cannot get a job? How would the project affect outfitters?

(19) Taxes. Would the mine increase property taxes by raising property values? How would taxes be affected?

(20) Mine shutdown. What would happen to employment, income, and taxes when the mine closes? What measures would be taken to stabilize the tailing pond? What if the mine shuts down early? What if it closes temporarily?

(21) Milling chemicals. How toxic are the milling chemicals? Would they leak into the ground water or blow into the air? Would the mill produce hazardous wastes? How would they be handled and disposed of?

(22) Water use. How much water would the operation need? Would company withdrawals affect other water users?

(23) Natural hazards. What is the chance of landslides, floods, and earthquakes in the project area? What impact would they have? Could the tailing dam fail?

(24) Cumulative impacts. What would the impacts be if the mine stayed open much longer than expected? What if more mines opened in the area? How would the project affect the greater Yellowstone ecosystem?

PREVIOUS RESEARCH

The EIS analysis draws data from many sources, each containing the most up-to-date information available. The sources are listed in full under Literature Cited at the end of the EIS. The most important documents are also described here.

Of primary importance to the EIS is Stillwater Mining Company's plan of operations, or application for a mining permit. The plan contains detailed information on the company's entire operation. For those interested, the plan is available for review at the Department of State Lands, Helena, the U.S. Forest Service offices in Billings and Red Lodge, and at Stillwater County's planning offices in Columbus.

Incorporated by reference into the mining plan are the studies performed during 1980 and 1981 by Camp, Dresser, and McKee, a consulting firm that gathered information on the current environment of the project area. The data

IN-6 / Introduction

range broadly, covering such topics as hydrology, soils, vegetation, archaeological sites, wildlife, and fisheries. Much of the information found in the EIS comes from the descriptions and species inventories in the Camp Dresser and McKee studies. For those interested, the studies are available for review at the Department of State Lands, Helena, and the U.S. Forest Service, Billings and Red Lodge.

Additional information on big game comes from studies by the Montana Department of Fish, Wildlife and Parks. The species covered primarily include bighorn sheep, elk, mule deer, and white-tailed deer.

Information that forms the basis of the tailing pond alternatives evaluated in the EIS comes mainly from two siting studies. One, prepared under contract to Anaconda Minerals Company, was performed by Mountain States Mineral Enterprises (MSME). The second, prepared by the Department of State Lands and the Forest Service, was performed to corroborate and expand on the findings of the MSME study. The second study is summarized in appendix A, and both studies are on file and available for review at the offices of the Forest Service and Department of State Lands.

The power-line discussion is based on a preliminary report supplied by the Montana Power Company (MPC). A detailed analysis of the power-line corridors will be prepared by the Montana Department of Natural Resources and Conservation, when MPC submits a complete application for the Certificate of Environmental Compatibility and Public Need.

AGENCY RESPONSIBILITIES

A number of agencies have or could have jurisdiction over the Stillwater Project.

Montana Department of State Lands (DSL)

DSL administers the 1971 Montana Metal Mine Reclamation Act (also called the Hard Rock Mining Act), with which Stillwater Mining Company must comply. The purposes of the act are, first, to recognize and protect the usefulness, productivity and scenic values of the lands and waters within the state, and second, to reclaim to beneficial use the lands used for metal mines. The act and its regulations (ARM 26.4.101 et seq.) set forth the steps that must be taken in the issuance of an operating permit for, and the reclamation of, Stillwater Mining Company's proposed mine and mill. The act applies to all lands within Montana. Thus, the Department of State Lands will regulate mining activity on both federal and private lands.

U.S. Forest Service

The Forest Service has authority for permitting and regulating all operations and uses of national forest system lands. Figure II-3 shows national forest system lands at the project site.

The 1872 General Mining Law, as amended by the Multiple Surface Use Act (P.L. 167) of July 23, 1955, allows any prospector who discovers a valuable mineral deposit on national forest system lands open to mineral entry to locate and work on a mining claim. (See also 36 CFR 228.) At the same time, the Organic Administration Act of 1897 authorizes the Secretary of Agriculture to regulate occupancy and use of the national forests for the protection and management of national forest resources--this pertains to all national forest users, including prospectors and miners. The Forest Service thus retains the right to manage and dispose of surface resources on unpatented mining claims to the extent that this does not unreasonably interfere with mining activity.

(Note that mining claims are either patented or unpatented. Patented claims are lands formerly owned by the government that have become private property. Patented claims are not regulated by the Forest Service. Unpatented claims are lands for which the surface is still owned by the federal government and managed in this case by the Forest Service. Mining on unpatented claims (and on unclaimed lands) is subject to federal regulations. The claimant may patent a claim by demonstrating a discovery of a valuable mineral deposit and by complying with other legal requirements. Once a claim is patented, regulatory authority falls solely to DSL. Stillwater Mining Company's development would occur on both patented and unpatented claims.)

The U.S. Forest Service management policy for mining activity originates from the Mining and Mineral Policy Act of 1970, the National Materials and Minerals Policy, Research, and Development Act of 1980, and a number of executive (presidential) orders.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service administers the Endangered Species Act, as reauthorized in 1982, and the Bald Eagle Protection Act of 1940 (as amended). Federal agencies (in this case, the U.S. Forest Service) involved in actions potentially affecting threatened or endangered species must prepare a biological assessment to comply with the Endangered Species Act. If the assessment determines impacts would adversely affect threatened and endangered species, the preparing agency consults with the Fish and Wildlife Service to design measures to protect the affected species. Biological assessments on bald eagles and peregrine falcons were prepared by the Forest Service in 1982, 1984, and 1985 (U.S. Department of Agriculture, 1982, 1984, and 1985).

State Historic Preservation Office

The State Historic Preservation Office has the responsibility to cooperate with and to advise the Department of State Lands and Forest Service when potentially valuable historical, archaeological, or other cultural resources are located in a project area (Montana Antiquities Act [MCA 22-3-401 through 22-3-442], and the National Historical Preservation Act [P.L. 89-665 as amended and reauthorized E.O. 11593]). Part of the advice given to the Department may include comments on a company's plan for impact mitigation of sites eligible for nomination to the National Register of Historic Places. The office also reviews the EIS to ensure compliance with cultural resource regulations.

IN-8 / Introduction

The State Historic Preservation Office is responsible for issuing antiquities permits for projects on state-owned lands. The office seeks determinations from the Keeper of the National Register for sites believed to be eligible for listing on the National Register of Historic Places. During mine operation, the Department of State Lands is responsible for monitoring compliance with historic preservation and monitoring plans.

Montana Department of Health and Environmental Sciences

Air Quality Bureau

Stillwater Mining Company must apply for an air quality permit from the Air Quality Bureau of the Department of Health and Environmental Sciences (DHES). The permit would cover the mine, mill, and tailing sites, and would include all sources of emissions on the proposed permit area. The chief pollutant considered would be dust (particulate matter). Calculated levels must be within Montana ambient air quality standards before a permit can be issued.

Water Quality Bureau

Stillwater Mining Company must obtain from the Department of Health and Environmental Sciences' Water Quality Bureau a Montana Pollutant Discharge Elimination System (MPDES) permit, which would be required before waters from the mine facilities could be discharged to state surface or ground waters.

The company must construct and operate the proposed tailing pond to prevent water discharge, seepage, drainage, infiltration or flow that may pollute surface or ground waters. The company must submit complete plans and specifications of the tailing pond to the Department of Health and Environmental Sciences no less than 180 days prior to initial construction.

Hard Rock Mining Impact Board

The Hard Rock Mining Impact Board (Hard Rock Board) created by the passage of House Bill 718 in 1980 is attached to the Montana Department of Commerce for administrative purposes. It is a quasi-judicial board intended to act as a "referee" in hearing disputes between local government units (for example, Stillwater County, the town of Columbus, and school districts) and large-scale mineral developers over the impact mitigation plan prepared by the developer. In the impact mitigation plan, the developer identifies the increased public sector costs associated with major mineral development and commits to pay, according to a specified time schedule, all increased capital and net operating cost to local government units that will be a result of the development.

The review of the impact plan by the Hard Rock Board is intended to occur concurrently with the procedure for fulfilling the operating permit requirements. If disagreement occurs between Stillwater County or any affected unit of local government and the proponent, the disagreeing party can file an objection with the Hard Rock Board.

An operating permit issued by the Department of State Lands for a large scale mineral development shall be conditioned to provide that mining may not commence until the Hard Rock Board approves the impact plan and until the permittee has provided a written guarantee to DSL and to the Hard Rock Board of compliance within the time schedule with the commitment made in the impact plan approved by the Hard Rock Board. If the permittee does not comply with that commitment within the time scheduled, the State Board of Land Commissioners, upon receipt of written notice from the Hard Rock Board, shall suspend the permit until it receives written notice from the Hard Rock Board that the permittee is in compliance.

Stillwater County

Stillwater County has the option to--

- o Adopt zoning regulations pursuant to 76-2-101 through 76-2-112, MCA, (if properly petitioned) that would control the location of the mill and tailing site.
- o Review and issue a floodplain development permit for any activity that infringes on the 100-year floodplain.

The county previously adopted a zoning regulation using the petition process that set up a planning and zoning district in southern Stillwater County. The regulation required that a zoning permit be obtained before an ore processing mill site could be located in the district. Although the proposed mill would not be located in an existing planning and zoning district, the county could expand the boundaries of the district to take in the proposed mill site or establish a new district.

Army Corps of Engineers

The Corps of Engineers would require a 404 permit if any bridges are replaced or strengthened in a manner that would put fill in any river. Need for a 404 permit is not anticipated at this time.

Local Conservation District

Similarly, bridge construction plans would require approval by the local conservation district if the company were planning to alter streambanks.

ADMINISTRATIVE PROCESS

After evaluation of this EIS, both the Department of State Lands and the Forest Service have a number of options.

Department of State Lands

The Department of State Lands must take one of five administrative actions: (1) approve the permit as proposed, (2) take no action, (3) deny the permit, (4) approve the permit with modified mining or reclamation plans, and (5) approve the permit subject to stipulations.

1. Approve the Permit as Proposed

The environmental effects of approving Stillwater Mining Company's permit as proposed are contained in chapter IV.

2. Take No Action

If the Department were to take no action on the company's permit, the permit could be approved by default (82-4-337 Montana Codes Annotated [MCA]). The environmental effects of this action are the same as those discussed in chapter IV. No mitigating measures--methods to reduce expected impacts--would be required of the company.

3. Deny the Permit

The Department may deny the permit if the mining or reclamation plans violate the laws administered by the Department of State Lands or the water and air quality laws administered by the Department of Health and Environmental Sciences.

If the permit is denied, the environmental, social, and economic changes identified in chapter IV would not occur.

4. Approve the Permit with Modified Mining or Reclamation Plans

If the proposed plan were unacceptable, the Department could return it with a request that the company submit a modified plan. If, for example, the Department selected an alternative from chapter IV different from Stillwater Mining Company's proposal, the Department would require the company to submit new project plans.

5. Approve the Permit Subject to Stipulations

If parts of the proposed plan were considered unacceptable, the Department could grant the permit with stipulations. Possible stipulations would include any modifications or additions to the proposed plans that the Commissioner considered necessary to meet the requirements of state laws.

U.S. Forest Service

Four administrative actions, some of which differ from those available to the Department of State Lands, will be considered by the U.S. Forest Service: (1) no action, (2) approve the plan of operations as submitted, (3) approve a revised plan of operations with changes incorporated, and (4) approve parts of the plan that are acceptable; defer decisions on other portions of the plan.

If the plan of operations is approved, the Forest Service would periodically inspect operations to determine if Stillwater Mining Company is complying with the approved plan. If the company fails to comply with the regulations or approved plan of operations and if the noncompliance is unnecessarily or unreasonably causing injury, loss, or damage to surface resources, the Forest Service would notify the company in writing of the noncompliance, specify the action needed, and specify the time period for completing the action (36 CFR 228.7 and 36 CFR 228.9). The plan of operations, essentially a contract between the Forest Service and the Stillwater Mining Company, would be effective as long as mining is conducted or reclamation is required. The period of liability under the Forest Service bond would be consistent with long-term reclamation needs.

1. No Action

Under this action, the proposed plan of operations would be denied and, theoretically, no mining could take place; however, this alternative is not valid because under the 1872 mining law the national forest lands on which the project would occur are open to mineral location and entry. Consequently, the Forest Service cannot take "no action" if Stillwater Mining Company meets legal and policy requirements and takes reasonable measures to protect surface resources and public safety.

2. Approve the Plan of Operations as Submitted

If the Forest Service agrees that the plan of operations is complete and adequate as submitted and no changes are required, the Forest Service would approve it.

3. Approve a Revised Plan of Operations With Changes Incorporated

If the plan of operations as proposed were deemed generally acceptable but in need of some revisions, the Forest Service could require changes. These changes would be for management and protection of the surface resources of national forest system lands or public safety. Such changes could not be aimed at managing mineral resources because the Forest Service does not have the authority to regulate mining activities that do not affect either the surface resource or public safety.

This administrative action would be selected if the Forest Service chooses to require an alternative different from the company's proposal or to require any of the mitigating measures recommended in the EIS. If the Forest Service does select an alternative different from Stillwater Mining Company's proposal, the company would be required to submit modified mining plans.

4. Approve Parts of the Plan of Operations

The Forest Service could approve part of the plan of operations and defer decisions on other parts of the proposal until further design data or specific information is available. The Forest Service would take action on these aspects of the proposal based on the degree to which they meet the objectives of reasonable environmental protection.

COMPARING ALTERNATIVES AND SELECTING THE PREFERRED ALTERNATIVE

The conclusion of the EIS is embodied in the preferred alternative. For the Stillwater Project, the preferred alternative has four parts:

- o A production system, chosen from seven systems under consideration.
- o A mine portal arrangement, chosen from three arrangements.
- o An electrical power supply, chosen from three options.
- o A public access route to the West Fork of the Stillwater River, chosen from two possibilities.

PRODUCTION SYSTEMS

The Choices

The proposal by Stillwater Mining Company (SMC) is to locate the mine facilities, including the mill and tailing pond, at the former Mouat Mill site (table I-1 and fig. I-1). Construction and operation of the project would disturb 165 acres, including 79 acres for the tailing pond and its earthen dam. The tailing pond would be lined with impervious hypalon sheeting. At the end of mining, the dam would hold 8.2 million tons of tailings and be 160 feet in height. Waste rock from the mine would be placed in mined-out portions of the underground workings and in the tailing pond dam. A small portion of FAS 419 and Forest Service Road (FR) 846 would be relocated around the tailing dam.

Alternative 1 (table I-1 and fig. I-1) would be similar to Stillwater Mining Company's proposal, with exception that the mined-out underground workings would be backfilled with 3.6 million tons of coarse tailings. The acreage covered by the tailing impoundment would be reduced by 33 percent (53 acres), and the height of the dam would be reduced to 100 feet.

Alternative 2 calls for locating the tailing impoundment at Stratton Ranch (fig. I-1). The dam would also be built with earth. The pond would be lined with hypalon. The dam and pond would cover about 116 acres and reach 125 feet in height. The mill would remain at the minesite, and tailings from the mill would be slurried 2 miles through a pipeline to the tailing impoundment. The mine would not be backfilled with tailings; at the end of mining, the impoundment would hold 8.2 million tons of tailings. A 10- to 15-acre emergency pond would have to be constructed at the minesite.

Alternative 3 would be the same as alternative 2, except that 3.6 million tons of tailings would be backfilled into the mine. Backfilling with tailings would reduce the surface area of the tailing impoundment by 34 percent and reduce the height of the tailing dam to 82 feet.

TABLE I-1

Major Components of Proposed and Alternative Production Systems

I-2 / Comparison of Production System Alternatives

Proposal	Mining Method	Ore Transport and Production	Mill Location	Tailing Transportation	Tailing Pond Site, Capacity, & Construction	Reclamation	Comments
Alternative 1	Shrinkage stoping. Backfill with waste rock. Eleven portals.	None 1,000 tons/day	Minesite		Minesite; 8.2 mm tons; earthen dam; hypalon liner; staged construction.	Comparable standard of stability & utility.	
	Shrinkage stoping with backfill of tailings (coarse sands, 3.6 mm tons) and waste rock. Eleven portals.	None 1,000 tons/day	Minesite		Minesite; 4.6 mm tons; earthen dam; hypalon liner; stage construction similar to SMC proposal. Dispose of slime fraction of tails only.	Comparable standard of stability & utility.	
Alternative 2	Shrinkage stoping; backfill with waste rock. Eleven portals.	None 1,000 tons/day	Minesite	Slurry; pipeline along FAS 419, approximately 2 miles in length. Slurry full volume of tails.	Stratton Ranch; 8.2 mm tons; Earthen dam; Hypalon liner; staged construction similar to SMC proposal.	Comparable Standard of stability & utility.	Would require emergency spill pond at minesite. Water in tailing pond would be returned to mill.
Alternative 3	Shrinkage stoping with backfill of tailings (coarse sands, 3.6 mm tons) and waste rock. Eleven portals.	None 1,000 tons/day	Minesite	Slurry; pipeline along FAS 419, approximately 2 miles. Slurry only slime fraction of tailings.	Stratton site; 4.6 mm tons; earthen dam; hypalon liner; Staged construction similar to SMC proposal. Dispose of slime fraction of tails only.	Comparable standard of stability & utility.	Would require emergency spill pond at minesite. Water in tailing pond would be returned to mill.
Alternative 4	Shrinkage stoping; backfill with waste rock. Eleven portals.	None 1,000 tons/day	Minesite	Slurry; pipeline along FAS 419, approximately 7 miles in length. Slurry full volume of tails.	Hertzler; 8.2 mm tons; coarse fraction sands, center-line construction; no liner.	Comparable standard of stability & utility.	Would require emergency spill pond at minesite. Water would be returned from tailing pond to mill.
Alternative 5 (Modified AMC Proposal)	Shrinkage stoping. Backfill with waste rock. Eleven portals.	Truck on FAS 419 and 420 (20-25 ton capacity) 1,000 tons/day	Hertzler Site	No slurry of tails.	Hertzler; 8.2 mm tons; coarse fraction sands, center-line construction; no liner.	Comparable standard of stability & utility.	
Alternative 6	Shrinkage stoping with backfill of tailings (coarse sands, 3.6 mm tons) and waste rock. Eleven portals.	None 1,000 tons/day	Minesite	Slurry; pipeline along FAS 419. Approximately 7 miles in length. Slurry only slime fraction of tails.	Hertzler; 4.6 mm tons; earthen dam; no liner; staged construction similar to SMC proposal. Dispose of slime fraction of tails only.	Comparable standard of stability & utility.	Would require emergency spill pond at minesite. Water in tailing pond would be returned to mill.

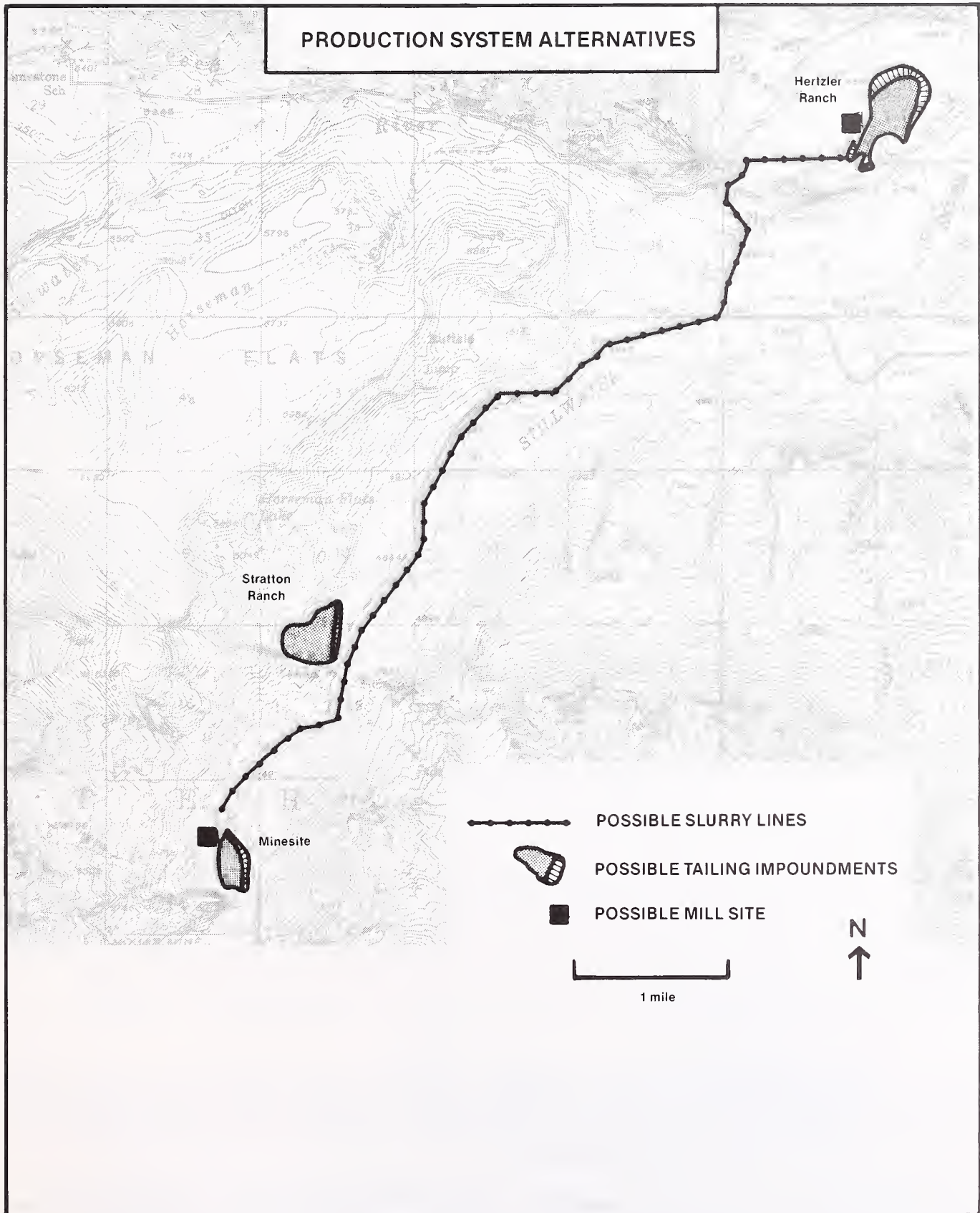


FIGURE I-1

The proposal and six alternative production systems have been evaluated in the EIS. The seven systems comprise differing arrangements of mining methods, ore transportation methods, mill locations, tailing transportation methods, and tailing impoundment locations.

I-4 / Comparison of Production System Alternatives

Alternative 4 calls for locating the tailing pond at Hertzler Ranch. The mill would remain at the minesite. Tailings would be slurried 7 to 9 miles through a pipeline located in the county road right-of-way (FAS 419 and 420). The dam would be constructed with coarse tailing sands and would not be lined with an impervious hypalon liner. The mine would not be backfilled with tailings. At the end of mining, the impoundment would hold 8.2 million tons of tailings, would cover about 161 acres, and would reach 108 feet in height. A 10- to 15-acre emergency tailing pond would be required at the minesite.

Alternative 5 calls for locating both the mill and tailing impoundment at the Hertzler Ranch. Ore would be trucked along FAS 419 and 420 to the mill. The impoundment would be constructed with coarse tailing sands and would have the same surface area and height as alternative 4 at the end of mining. As in alternative 4, the pond would not be lined. There would be no emergency tailing pond at the minesite.

Alternative 6 would be similar to alternative 4, except that the mine would be backfilled with 3.6 million tons of coarse tailings. Backfilling would necessitate that the Hertzler tailing impoundment be constructed of earth. No liner would be installed. Backfilling would reduce the size of the tailing pond by about 20 percent and reduce the height of the dam to 85 feet.

Impacts of the proposal and alternatives are compared in table I-2. Impacts are described for each alternative and the proposal. The table indicates whether mitigating measures would reduce the impact to an acceptable level.

The Preferred Production System Alternatives

Two production systems are acceptable: the company's proposal and alternative 4. Alternative 4 is considered by the agencies to be environmentally superior. The agencies, after evaluating public comments on the draft EIS, will select a single preferred production system in the final EIS.

The agencies used eight criteria to select the most acceptable production systems. The selection criteria address (1) those impacts or potential impacts that differ sharply among the alternatives and the proposal and (2) those impacts that are major public concerns. No selection criteria were developed to address impacts that are common to all alternatives and the proposal.

The selection criteria:

- 1) Dam Stability. The tailing site should accommodate the tailing impoundment without requiring special design measures to ensure its stability. For example, sites with unstable ground or a high ground water table are undesirable.
- 2) Impoundment Spill Control. The tailing impoundment location should provide opportunities to control surface and ground water discharges resulting from impoundment breaching or leaking. Sites near the Stillwater River are less favored than those farther away.

Comparison of Production System Alternatives / I-5

- 3) Slurry Line Rupture. Risk of rupture should be low; the potential to contain a spill should be high. Topographic constraints could stress slurry line systems.
- 4) Reclamation Success. Tailing pond design should incorporate devices to reliably dewater tailings after shutdown to provide a stable surface to support vegetation and postmining land uses.
- 5) Expansion Potential. The tailing impoundment should have the capacity to accommodate an extended mine life (in excess of 30 years) should the company find additional reserves. Sites that can hold more waste are more desirable because the need for additional disposal sites in the long run would be reduced or eliminated.
- 6) Cost. The cost of environmental mitigation must have tangible public benefit.
- 7) Other Wildlife. Long-term, adverse impacts to mule deer herd populations should be minimized. (Since all alternatives and the proposal pose similar impacts to bighorn sheep and elk, selection criteria for these species are not considered in the comparative evaluation.)
- 8) Threatened and Endangered Wildlife. Adverse impacts on threatened and endangered species must be mitigable as required by the Endangered Species Act.
- 9) Public Safety. Average daily traffic on FAS 419 should be minimized. Measures to assure public safety should be available to mitigate the effects of surface subsidence.
- 10) Visual Resource. Visual impacts should be minimized.

Rationale: Alternative 4 is considered environmentally superior because it meets more selection criteria than any other alternative or the proposal.

- o Dam Stability. The Hertzler Valley tailing disposal site is hydrologically and geologically favorable for the construction and operation of a cycloned coarse-sand tailing dam.
- o Spill Control. The Hertzler site would provide sufficient distance between the impoundment and the Stillwater River to control a failure of the dam or contaminated seepage.
- o Slurry Line Rupture. Although this alternative would have a 7-mile slurry line, the risk of rupture would be low. Adequate safeguards could be designed into the line to minimize the risk of rupture and immediately control a spill.
- o Threatened and Endangered Species. Alternative 4 would have no effect on threatened and endangered species. Noise levels at the Hertzler site would not disrupt possible peregrine falcon nesting at the nearby cliff complex.

TABLE I-2---Stillwater Project Summary of Impacts with Indication of Mitigation

	1	2	3	4	5	6
Geology	-Minimal hazard to public safety from crown pillar collapse and surface subsidence (DM).	-Minimal hazard to public safety from crown pillar collapse and surface subsidence (DM).	-Minimal hazard to public safety from crown pillar collapse and surface subsidence (DM).	-Minimal hazard to public safety from crown pillar collapse and surface subsidence (DM).	-Minimal hazard to public safety from crown pillar collapse and surface subsidence (DM).	-Minimal hazard to public safety from crown pillar collapse and surface subsidence (DM).
Hydrology	-Minimal change in surface and ground water quality. No effect on present or future water uses.	-Minimal change in surface and ground water quality. No effect on present or future water uses.	-Minimal change in surface and ground water quality. No effect on present or future water uses.	-Minimal change in surface and ground water quality. No effect on present or future water uses.	-Minimal change in surface and ground water quality. No effect on present or future water uses.	-Minimal change in surface and ground water quality. No effect on present or future water uses.
Reclamation	-Lower vegetative densities, species diversity, and plant vigor after mining and reclamation due to soil salvage and storage plans (M).	-Lower vegetative densities, species diversity, and plant vigor after mining and reclamation due to soil salvage and storage plans (M).	-Lower vegetative densities, species diversity, and plant vigor after mining and reclamation due to soil salvage and storage plans (M).	-Lower vegetative densities, species diversity, and plant vigor after mining and reclamation due to soil salvage and storage plans (DM).	-Lower vegetative densities, species diversity, and plant vigor after mining and reclamation due to soil salvage and storage plans (DM).	-Lower vegetative densities, species diversity, and plant vigor after mining and reclamation due to soil salvage and storage plans (DM).
Wildlife	-Temporary displacement of mule deer (NM).	-Temporary displacement of mule deer (NM).	-Temporary displacement of mule deer (NM).	-Temporary displacement of mule deer (NM).	-Temporary displacement of mule deer (NM).	-Temporary displacement of mule deer (NM).
	-Private vehicle road kills (M).	-Private vehicle road kills (M).	-Private vehicle road kills (M).	-Private vehicle road kills (M).	-Haul truck/private vehicle road kills (M).	-Private vehicle road kills (M).
	-Potential adverse (physiological and behavioral) effects on bighorn (DM).	-Potential adverse (physiological and behavioral) effects on bighorn (DM).	-Potential adverse (physiological and behavioral) effects on bighorn (DM).	-Potential adverse (physiological and behavioral) effects on bighorn (DM).	-Potential adverse (physiological and behavioral) impacts on bighorn (DM).	-Potential adverse (physiological and behavioral) impacts on bighorn (DM).
	-Impacts associated with increased human population (DM).	-Impacts associated with increased human population (DM).	-Impacts associated with increased human population (DM).	-Impacts associated with increased human population (DM).	-Impacts associated with increased human population (DM).	-Impacts associated with increased human population (DM).
Threatened & Endangered Species	-Mine construction & operational activities interfering with bald eagle feeding (M).	-Construction noise interfering with bald eagle roosting (M).	-Construction noise interfering with bald eagle roosting (M).	-Construction noise interfering with potential peregrine falcon nesting (M).	-Disturbance of peregrine falcon nest site by trucks (M).	-Construction noise interfering with potential peregrine falcon nesting (M).
Transportation	-Added traffic between Columbus and minesite (M).	-Added traffic between Columbus and minesite (M).	-Added traffic between Columbus and minesite (M).	-Added traffic between Columbus and minesite (M).	-Added traffic between Columbus and minesite (M).	-Added mine worker traffic between Nye and minesite (M).
	-No road improvements.	-No road improvements.	-No road improvements.	-No road improvements.	-Additional truck traffic on FAS 419 (NM).	-No road improvements.
	-Additional accidents and inconvenience to livestock movers (M).	-Additional accidents and inconvenience to livestock movers (M).	-Additional accidents and inconvenience to livestock movers (M).	-Additional accidents and inconvenience to livestock movers (M).	-Additional truck traffic on FAS 419 (NM).	-Additional accidents.
					-Road improvements between mill and minesite.	-Road improvements between mill and minesite.
					-Inconveniences to livestock movers (M).	-Inconveniences to livestock movers (M).

Aquatic Ecology	-No impact.	-No impact.	-No impact.	-Slurry may spill into river (M). -Increased fishing pressure (DM).	-No impact.	-Slurry may spill into river (M). -Increased fishing pressure (DM).	-Slurry may spill into river (M). -Increased fishing pressure (DM).
	-Increased fishing pressure (DM).	-Increased fishing pressure (DM).	-Increased fishing pressure (DM).	-Increased fishing pressure (DM).	-Increased fishing pressure (DM).	-Increased fishing pressure (DM).	-Increased fishing pressure (DM).
Aesthetics	-Significant visual impact at minesite--mine & mill (NM). -Tailing site--major disturbance, highly visible. Site previously disturbed. Noticeable postmining impact.	-Significant visual impact at minesite--mine & mill (NM). -Tailing site--major disturbance & highly visible. Low postmining visual impact, but noticeable.	-Significant visual impact at minesite--mine & mill (NM). -Tailing site--major disturbance & highly visible. Postmining would be visible, but low impact.	-Significant visual impact at minesite--mine & mill (NM). -Tailing site--drastic disturbance, but not very visible. Low postmining visual impact.	-Significant visual impact at minesite--mine & mill (NM). -Tailing site--drastic disturbance, but not very visible. Low postmining visual impact.	-Significant visual impact at minesite--mine & mill (NM). -Tailing site--drastic disturbance, but not very visible. Low postmining visual impact.	-Significant visual impact at minesite--mine & mill (NM). -Tailing site--drastic disturbance, but not very visible. Low postmining visual impact.
	-No impact (from slurry line).	-No impact (from slurry line).	-No impact (from slurry line).	-No impact (from slurry line).	-No impact (from slurry line).	-No impact (from slurry line).	-No impact (from slurry line).
Air Quality	-No significant impact.	-No significant impact.	-No significant impact.	-No significant impact.	-No significant impact.	-No significant impact.	-No significant impact.
	-Vandalism (DM).	-Vandalism (DM).	-Vandalism (DM).	-Vandalism (DM).	-Vandalism (DM).	-Vandalism (DM).	-Vandalism (DM).
Cultural Resources	-Mine & mill may disturb cultural sites (M).	-Mine & mill may disturb cultural sites (M).	-Mine & mill may disturb cultural sites (M).	-Mine & mill may disturb cultural sites (M).	-Mine & mill may disturb cultural sites (M).	-Mine & mill may disturb cultural sites (M).	-Mine & mill may disturb cultural sites (M).
	-No significant impact.	-No significant impact.	-No significant impact.	-No significant impact.	-No significant impact.	-No significant impact.	-No significant impact.
Land Use	-Small conflict with worker/recreational traffic (M). -No significant impact on recreational resources.	-Small conflict with worker/recreational traffic (M). -No significant impact on recreational resources.	-Small conflict with worker/recreational traffic (M). -No significant impact on recreational resources.	-Small conflict with worker/recreational traffic (M). -No significant impact on recreational resources.	-Small conflict with worker/recreational traffic (M). -No significant impact on recreational resources.	-Small conflict with worker/recreational traffic (M). -No significant impact on recreational resources.	-Small conflict with worker/recreational traffic (M). -No significant impact on recreational resources.
	-Minor impact on community recreational resources (M).	-Minor impact on community recreational resources (M).	-Minor impact on community recreational resources (M).	-Minor impact on community recreational resources (M).	-Minor impact on community recreational resources (M).	-Minor impact on community recreational resources (M).	-Minor impact on community recreational resources (M).
Recreation	-No impact.	-No impact.	-No impact.	-No impact.	-No impact.	-No impact.	-No impact.
	-Beneficial effect of creating jobs.	-Beneficial effect of creating jobs.	-Beneficial effect of creating jobs.	-Beneficial effect of creating jobs.	-Beneficial effect of creating jobs.	-Beneficial effect of creating jobs.	-Beneficial effect of creating jobs.
Climate	-Beneficial effect from added taxable value.	-Beneficial effect from added taxable value.	-Beneficial effect from added taxable value.	-Beneficial effect from added taxable value.	-Beneficial effect from added taxable value.	-Beneficial effect from added taxable value.	-Beneficial effect from added taxable value.
	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).
Employment & Income	-Slight adverse impact (NM).	-Slight adverse impact (NM).	-Slight adverse impact (NM).	-Slight adverse impact (NM).	-Slight adverse impact (NM).	-Slight adverse impact (NM).	-Slight adverse impact (NM).
	-Slight adverse impacts (M).	-Slight adverse impacts (M).	-Slight adverse impacts (M).	-Slight adverse impacts (M).	-Slight adverse impacts (M).	-Slight adverse impacts (M).	-Slight adverse impacts (M).
Fiscal	-No impact.	-No impact.	-No impact.	-No impact.	-No impact.	-No impact.	-No impact.
	-Beneficial effect of creating jobs.	-Beneficial effect of creating jobs.	-Beneficial effect of creating jobs.	-Beneficial effect of creating jobs.	-Beneficial effect of creating jobs.	-Beneficial effect of creating jobs.	-Beneficial effect of creating jobs.
Sociology	-Beneficial effect from added taxable value.	-Beneficial effect from added taxable value.	-Beneficial effect from added taxable value.	-Beneficial effect from added taxable value.	-Beneficial effect from added taxable value.	-Beneficial effect from added taxable value.	-Beneficial effect from added taxable value.
	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).	-Some affected jurisdictions may not benefit from increase in taxable value proportional to the increase in added cost (M).
Community Services	-Slight adverse impact (NM).	-Slight adverse impact (NM).	-Slight adverse impact (NM).	-Slight adverse impact (NM).	-Slight adverse impact (NM).	-Slight adverse impact (NM).	-Slight adverse impact (NM).
	-Slight adverse impacts (M).	-Slight adverse impacts (M).	-Slight adverse impacts (M).	-Slight adverse impacts (M).	-Slight adverse impacts (M).	-Slight adverse impacts (M).	-Slight adverse impacts (M).

(M)--impact is mitigable to an acceptable level.
(DM)--impact would be difficult to mitigate or measures to reduce impact are not foolproof.
(NM)--impact not mitigable; either technologically or economically.

I-8 / Comparison of Production System Alternatives

- o Other Wildlife. Although more acreage of mule deer habitat would be destroyed than by any other production system, the loss would be temporary, assuming successful revegetation after shutdown.
- o Reclamation Success. Dewatering of the tailings at the end of mining would probably be more easily achieved at the Hertzler site than at the other sites, owing to the unlined pond design and the underdrain system. Stable surface conditions would be more likely to result, enhancing the success of revegetation.
- o Visual Resource. Bush Mountain would prevent motorists that use FAS 419 from viewing the Hertzler tailing pond, although the pond would be visible from FAS 420. The tailing line would have low visual impact, since the line would be buried.
- o Public Safety and Welfare. Average daily traffic on FAS 419 would be the same under alternative 4 as under the proposal and all alternatives (except alternative 5). Since a slurry line instead of haul trucks would service the Hertzler Valley disposal site, truck traffic on FAS 419 would be eliminated. Only a minimal risk to public safety would result from potential subsidence at the minesite. Nearly the same risk would result under all alternatives and the proposal.
- o Expansion Potential. Generous expansion potential is available at the Hertzler tailing disposal site; the company would not need other tailing disposal sites if the mine life extended beyond 30 years.
- o Cost. The cost of alternative 4 would range between \$8.0 and \$10.5 million. Given the level of accuracy ($\pm 20-40\%$) of the cost estimates, alternative 4 is similar to the proposal (\$7.3 to \$9.4).

The other production system preferred by the agencies is the proposed system:

- o Dam Stability. No geologic features are known that would preclude constructing the tailing pond at the minesite. The dam slopes would meet or exceed safety standards established by the Army Corps of Engineers (1970), although further studies would be needed to establish final impoundment design.
- o Spill Control. The short distance to the Stillwater River is an undesirable feature of this production system configuration. Spills, especially ground water leakage, could be difficult to contain. However, design and installation of an underdrain system on the floor of the impoundment with a collection and pump-back system would provide an acceptable leakage control system. Installation of the underdrain system would be required to make this an acceptable production system option. In addition, the toe dam would prevent spills resulting from breaching from reaching the Stillwater River.
- o Slurry Line Rupture. Risk of slurry line rupture in the proposed plan would be low; a spill would be easily contained by the tailing impoundment.

Comparison of Production System Alternatives / I-9

- o Reclamation Success. Unexpected operational problems could impair dewatering, since Stillwater Mining Company's plan has not been tried and tested in areas with similar climatic conditions. An underdrain system included in the final impoundment design would also help dewater the tailings, providing for a stable surface for reclamation. This modification would probably assure that reclamation is as successful as at the Hertzler site.
- o Threatened and Endangered Wildlife. The proposal would have no adverse effects on threatened and endangered species.
- o Other Wildlife. A small amount of mule deer habitat would be disrupted, and a small portion of marginal bighorn sheep winter range would be destroyed at the minesite by the tailing impoundment. The loss of this habitat would have a negligible effect on bighorn. Activities and noise due to construction of the dam would also have a negligible impact.
- o Visual Resource. The tailing pond would significantly affect visual resources at the minesite during and after mining; however, mining disturbances would be confined mostly to lands previously disturbed by mining.
- o Public Safety. Traffic on FAS 419 would be similar to all alternatives (except alternative 5). As in alternative 4, only a minimal risk to public safety would result from potential subsidence at the minesite.
- o Expansion Potential. There would be no potential for expanding the tailing pond capacity at the minesite beyond the 30-year mine life. The only opportunity for extending the life of the mine without constructing a new tailing pond would be if the company were to backfill tailings into the mine cavity.
- o Cost. As mentioned above, the cost would be in the same range as for alternative 4.

Alternatives Rejected

Alternatives 2 and 3 would have advantages and disadvantages similar to those of the proposal. Although acceptable, these alternatives were ruled out because of uncertainties about unstable ground at the Stratton Ranch tailing pond site and high ground water conditions. Both conditions would require special drainage measures to prevent slope destabilization and to assure foundation integrity. In addition, the tailing ponds would be visible from residences in the Cathedral Mountain Estates Subdivision.

The mine backfill alternatives (alternatives 1 and 6) would reduce the severity of surface subsidence, but could possibly double total project costs. These alternatives would serve only to mitigate the minimal hazard to public safety posed by subsidence and somewhat lessen the potential adverse effects of the larger tailing impoundments. All other environmental advantages and disadvantages would be similar to those of the proposal and alternative 4. The cost of the backfill alternatives could range from \$14.94 to \$18.85 million.

I-10 / Comparison of Production System Alternatives

Alternative 5, when judged by the eight selection criteria, is an acceptable alternative. However, it was dismissed because locating the mill in Hertzler Valley would preclude the company from backfilling the mine with tailings. The tailings would help control spalling (flaking) of rock within the mine and the consequent dilution of the ore in the stopes. The environmental advantages and disadvantages of alternative 5 are similar to alternative 4--with the following exceptions:

- o Trucking ore to the mill at the Hertzler Valley would increase average daily traffic on FAS 419 and FAS 420. The increase would amount to a relatively small percentage of the total traffic resulting from the mine. The added traffic would not cause a significant hazard to the public, although the haul trucks would detract from the rural setting and possibly cause inconveniences.
- o Haul trucks could affect potential peregrine falcon nesting at the historic cliff complex located near FAS 420. However, relocating the haul road would mitigate the potential adverse effects.
- o Haul trucks would consume added fuel compared to the other alternatives.
- o Added traffic due to haul trucks and noise from construction and operation of the mill would increase impacts to mule deer.
- o The cost of alternative 5 would range from \$4.41 to \$8.01 million. These costs are comparable to the company's proposal, considering the accuracy of cost-estimating procedures.

MINE PORTALS

The Choices

Eleven portals (mine openings) are proposed to serve the underground workings (fig. I-2). A small service yard would be constructed with waste rock at each portal. Four of the portals would require a new road on the hillside above the main mine facilities.

Two alternatives (fig. I-2) are analyzed in this EIS that would reduce the amount of road construction and mountainside disturbance. In the first alternative, the company would use only the two existing portals: the Minneapolis portal (5,150 level) and the 6,550-level portal. This alternative would eliminate nine portals and associated yards and 1.4 miles of new road. In the second alternative the company would eliminate only three portals: the 5,950-, 6,150-, and 6,350-level portals. The yards and switch-back road associated with these three portals would similarly be eliminated. (See table I-3.) Note that the Mountain View shaft, associated service road, and associated power line would still be required under both alternatives and the proposal.

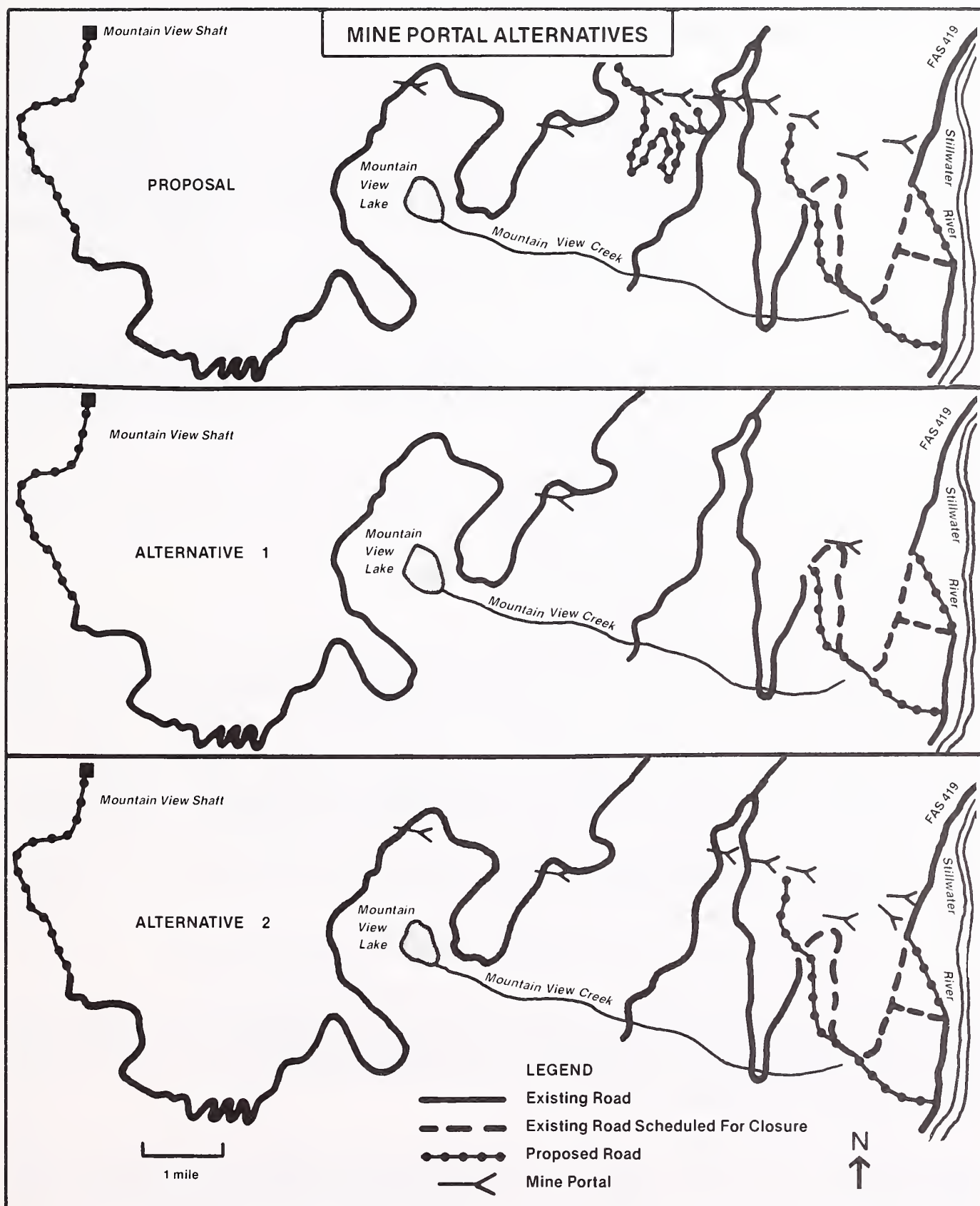


FIGURE I-2

Stillwater Mining Company proposes to use 11 portals to serve the underground workings. The EIS analyzes two alternatives: 8 portals and 2 portals. Reducing the number of portals would eliminate some new road construction.

I-12 / Comparison of Mine Portal Arrangements

TABLE I-3

Summary of Impacts from Mine Portals

	Proposal (11 portals)	Alternative 1 (2 Portals)	Alternative 2 (8 Portals)
Visual	Apparent visual intrusion from portals, access roads, and 13-kV power line.	Visual intrusion moderated by fewer portals, access roads, and alternate routing of 13-kV power line.	Slightly less, but similar visual intrusion compared to the proposal.
Reclamation	Loss of soil organic matter would result in low postmining water- and nutrient-holding capacities. This loss would result in lower vegetative density for several years following initial revegetation.	Same, but about 9 acres less disturbance.	Same, but about 3 acres less disturbance.

The Preferred Mine Portal Alternative

The preferred alternative is the portal arrangement proposed by the company. The selection criteria used to choose the preferred alternative include--

- (1) Minimize Visual Impact. Modifications should reduce the effects on visual resources.
- (2) Cost. The cost of mitigation should have public benefit.

Compared to alternatives 1 and 2 the proposal would result in the most road construction and mountainside disturbances. However, more portals and roads would not noticeably add to the visual impacts caused by the tailing dam and mine facilities. Reclamation of the portals and new roads after mining would minimize long-term visual impacts.

Cost of alternatives 1 and 2 could range 20 to 200 percent greater than the proposal. The added costs would not appreciably reduce the visual impact of the project.

POWER SUPPLY ALTERNATIVES

The Choices

The existing 50-kV (kilovolt) system serving the minesite could not adequately handle the 6 megawatts of electricity required by the proposed operation. Among the alternatives for supplying reliable power to the mine are construction of a new 161-kV transmission line and generating electricity on site.

Two alternative corridors for the 161-kV transmission line have been proposed by Montana Power Company (fig. I-3). In alternative 1 the transmission line would be constructed to a substation in Nye in a corridor from the existing 161-kV Anaconda-Billings transmission line at Big Timber. In alternative 2 the power line would be constructed to Nye in a corridor extending from the existing Anaconda-Billings 161-kV line at Big Sheep Creek. Both alternatives would use the existing line from Nye to the minesite.

In the third alternative, electricity could be generated at the mine rather than supplied by a new power line. Such a generating facility would probably be an oil-fired 7.4-megawatt turbine generator. (See table I-4.)

The Preferred Power Supply Alternative

The Montana Power Company (MPC) will submit in 1985 an application for construction of a 161-kV power line (pursuant to the Montana Major Facility Site Act) to the Department of Natural Resources and Conservation (DNRC) and the Department of Health and Environmental Sciences (DHES). The plan contained in the application will be subjected to extensive environmental study in which the agencies will evaluate alternative power-line routes and power supply alternatives. A preferred power supply alternative cannot be reliably identified until DNRC completes a thorough analysis of present and future load demands of the Stillwater area, the service capacities of alternatives, the environmental impacts, and the costs. An environmental impact statement will also be prepared by DNRC. After the EIS, the Boards of each department would decide whether or not to issue the Certificate of Need and Environmental Compatibility that is required for construction of the 161-kV power line.

ROAD ACCESS TO THE WEST FORK STILLWATER RIVER

The Choices

Stillwater Mining Company proposes to realign FAS 419 and FR 846 around the toe of the proposed tailing dam (fig. I-2). Another short segment of FR 846 would also be relocated around the mine buildings west of the tailing pond. Public access to the West Fork of the Stillwater, however, would continue via these roads through the proposed mine-mill complex (fig. I-2).

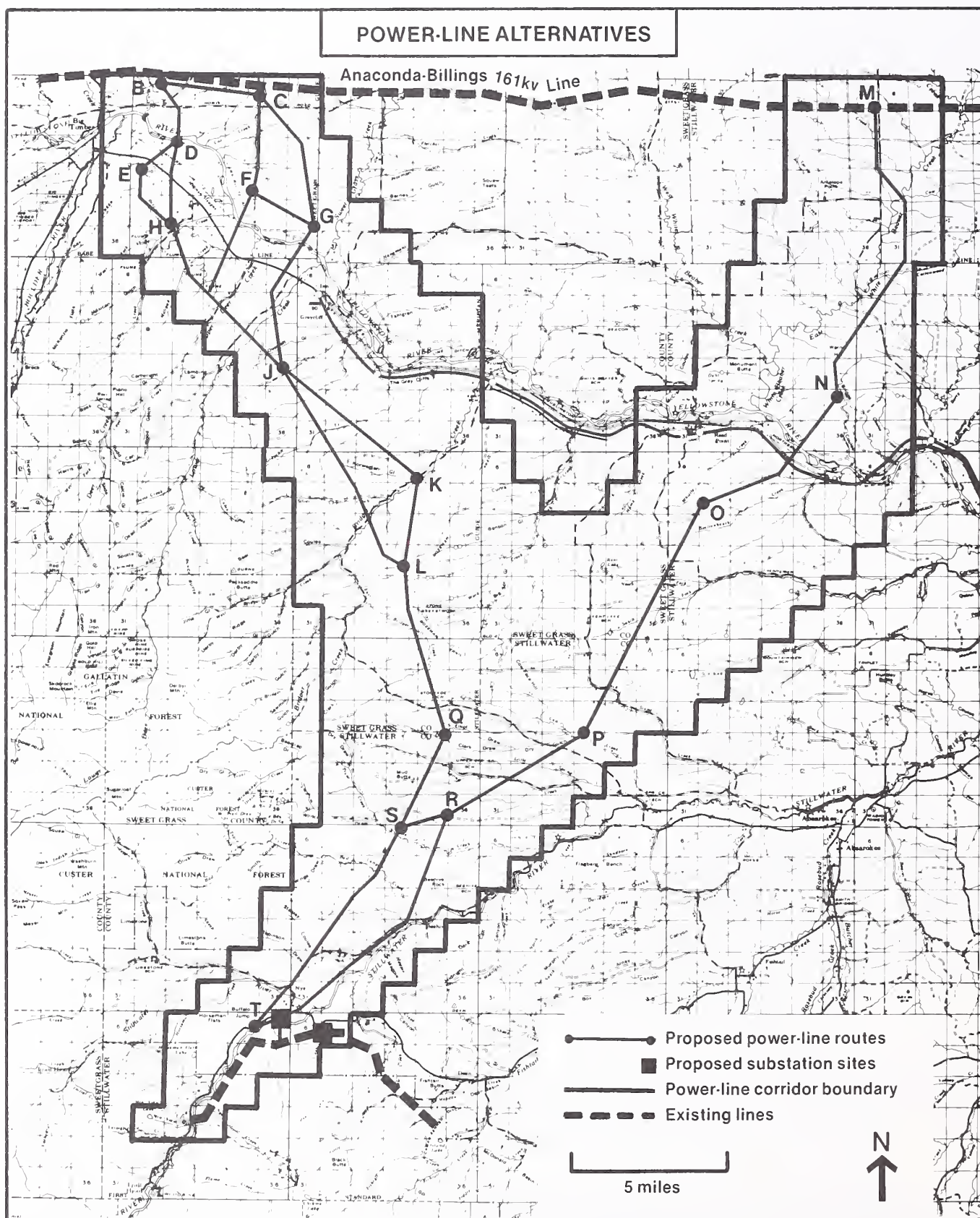


FIGURE I-3

Montana Power Company has identified two alternative corridors for the 161-kilovolt power line that is proposed to serve the project. Within each corridor the company is examining a variety of routes.

TABLE I-4

Summary of Impacts from Power Alternatives

	Big Timber Corridor (Alternative 1)	Sheep Creek Corridor (Alternative 2)	On-Site Generation (Alternative 3)
Air quality	No impacts	No impacts	Increase in SO ₂ , NO _x emissions.
Visual	Substation visible from FAS 419 and 420. Some line segments visible from I-90, FAS 419 and 420.	Same as alternative 1.	Visible from FAS 419 at minesite.
Reclamation	Would cross about 7.2 miles of highly ero- sive soils.	Would cross about 5.8 miles of highly erosive soils.	Slightly increase the amount of acreage occupied by the project.
Threatened and Endangered Species	Potential for nest desertion if pere- grine falcons use historic site.	Peregrine fal- cons not affected.	Peregrine falcons not affected.
Noise	No impacts.	No impacts.	Negligible impacts.
Transportation	Temporary, minor increases in con- struction-related traffic.	Temporary, minor increases in construction- related traffic.	Added truck traffic over life of mine (fuel-oil trucks).

Note: SO₂ = sulfur dioxide; NO_x = nitrogen oxides.

Reconstructing a short segment of road and constructing a bridge across the West Fork of the Stillwater River between the Picket Pin Creek Road (FR 140) and FR 846 (fig. I-4) would provide an alternative for public access to the West Fork of the Stillwater. This alternative would prevent the public from passing through Stillwater Mining Company's mine-mill complex. (See table I-5.)

The Preferred Road Access Alternative

The preferred alternative for access to the West Fork of the Stillwater is to reconstruct the short segment of abandoned road between the Picket Pin Creek Road and FR 846 west of Horseman Flats (Picket Pin Creek Road Alternative).

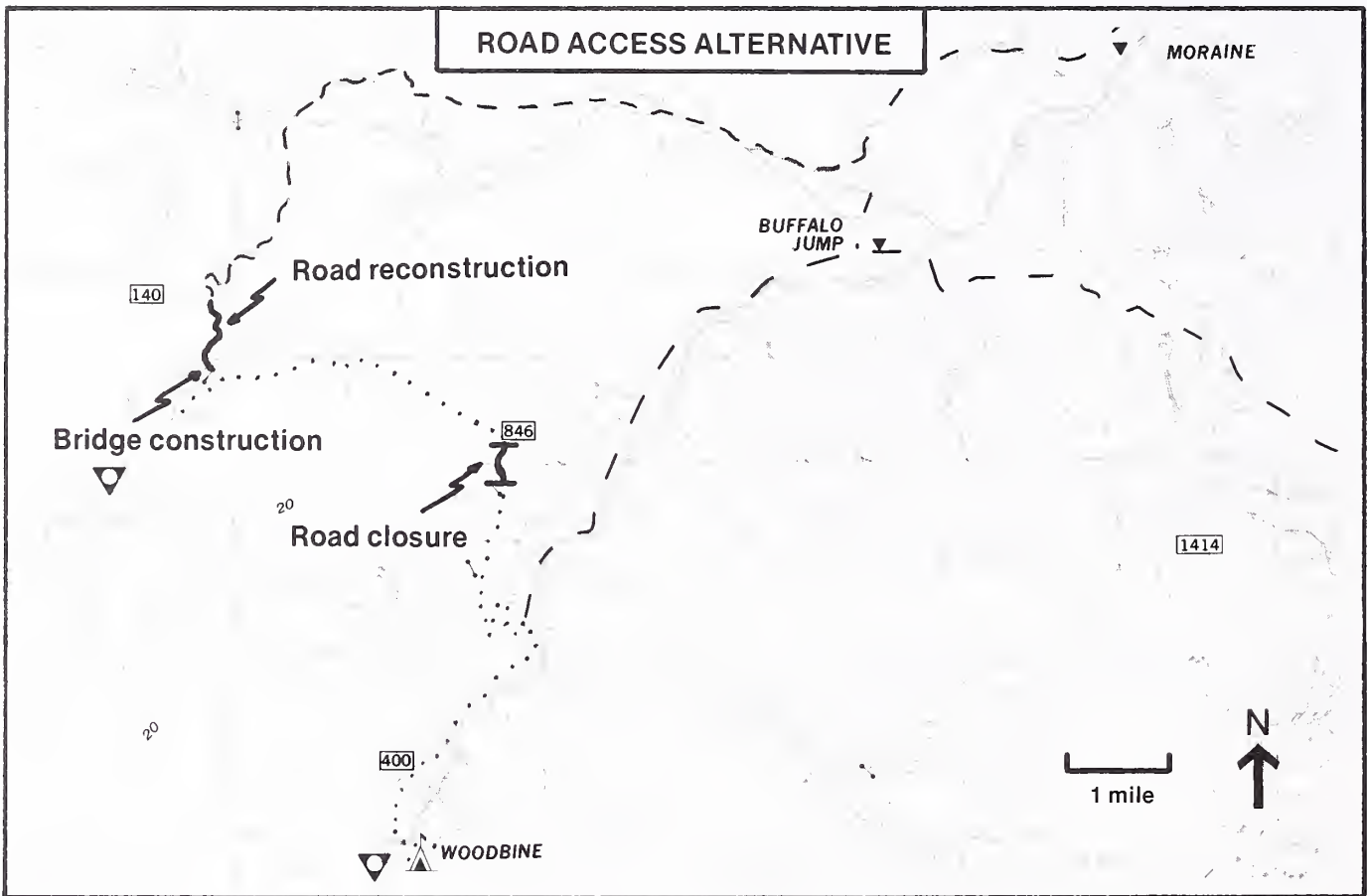


FIGURE I-4

Stillwater Mining Company proposes to maintain FR 846 as the access route to the West Fork of the Stillwater River. As an alternative, access could be provided by FR 140 and a segment of road that is now abandoned. The alternative would eliminate public traffic through the minesite.

Four selection criteria were used to evaluate the two access alternatives.

- (1) Public Safety. Potential public safety hazards and conflicts with Stillwater Mining Company operations should be minimized.
- (2) Transportation. Inconveniences and delays for forest users traveling to the West Fork trailhead should be limited.
- (3) Threatened and Endangered Wildlife. Adverse effects on threatened and endangered species must be mitigable as required by the Endangered Species Act.
- (4) Cost. The cost of environmental mitigation must have public benefit.
- (5) Visual. Exposure of the mineral development activities to recreationists should be minimized.

TABLE I-5
Summary of Impacts for West Fork Access

	Proposal	Picket Pin Creek Road
Visual	Offers greatest visual impact to public accessing West Fork of the Stillwater.	Offers least visual impact to public accessing West Fork of the Stillwater.
Transportation	Offers inconvenience and delays to public accessing West Fork of Stillwater.	No inconvenience or delays to public accessing West Fork of Stillwater.
	Shorter route to trailhead of the West Fork of Stillwater River.	Longer route to trailhead of West Fork of the Stillwater River.
Public Safety	Introduce potential for conflicts between mine traffic and public traffic.	No conflicts between mine traffic and public traffic.
Ownership	No land acquisition required.	Require acquisition of private land.
Wildlife	Minor intrusion on Horseman Flats' elk habitat.	Minor intrusion on Picket Pin elk habitat.
Threatened and Endangered Species	No impact.	May affect potential peregrine falcon nest site selection.
Cost	Minimal.	\$100,000-150,000 plus land-acquisition costs.

Removal of public traffic from the permit area during operations would eliminate potential conflicts between mine traffic and private vehicles. Inconveniences and delays to public travel caused by construction and blasting in the permit area would be avoided by routing access over the Picket Pin Road. Added assurance of public safety would also be gained after mining because sections of FR 846 in areas of potential surface subsidence could be permanently closed to vehicle access. The Picket Pin Road would also reduce views of the mining operation for forest users driving to the West Fork trailhead.

Benefits of public safety, convenience, and scenic preservation would be achieved at a cost of \$150,000 to \$200,000. The cost would stem from road reconstruction, bridge construction, and right-of-way acquisition. Right-of-way would have to be acquired before Stillwater Mining Company could implement

the preferred alternative. In addition, if the U.S. Fish and Wildlife Service concurs with the Forest Service's findings that the Picket Pin Road Alternative may effect potential nest site selection the agencies would prefer SMC's proposed road access alternative.

DEVELOPMENT OF ALTERNATIVES

The production system alternatives were developed by combining into varying arrangements preferred tailing pond locations, mining methods, and transportation schemes studied by the Department of State Lands and U.S. Forest Service.

Tailing Impoundment Siting

A tailing disposal site study (Montana Department of State Lands and U.S. Forest Service, 1984) was prepared as the basis for selecting tailing impoundment alternatives. (See appendix A.) The study identified and evaluated 18 potential tailing pond sites within 7 air miles of the minesite. Eleven of those sites were previously evaluated in a Mountain States Mineral Enterprises (MSME) siting study prepared for the Anaconda Minerals Company (MSME, 1981). The Department of State Lands and the U.S. Forest Service applied various "fatal flaw" and environmental criteria to rate the 18 alternative tailing pond sites. The five highest-ranking sites included Stratton Ranch, the minesite, and three locations at the Hertzler Ranch. Two Hertzler Ranch sites were eliminated because they offered no distinct advantage over the Hertzler site selected by Anaconda Minerals Company in 1982.

Another site, Horseman Flats (M) ranked close to the five best sites. Even so, this site was eliminated from further consideration for a number of reasons:

- o The site would result in direct loss of elk winter range, potential disruption of an elk calving area, and some displacement of the elk herd.
- o The pond would have to be served by a slurry line, requiring construction of a pipeline on a steep, potentially unstable slope.
- o A service road would be required, which would result in added adverse visual impact in the middle ground view from FAS 419.
- o Stillwater Mining Company's mill would not produce enough coarse tailings to build the large three-sided embankment that the topography of the site would require.
- o Although an earthen dam could be constructed, the cost of the dam, in addition to the cost of pumping tailings up steep terrain, would probably make the site the most costly.

Mining Method

Stillwater Mining Company has proposed mining the platinum-group metals by using shrinkage stopes. (See chapter II.) This method would leave the stopes empty after mining, posing a potential for crown pillar (mine roof) collapse, which could leave the underground cavity open to the surface. This potential problem has been a major concern of the public since publication of the Anaconda Stillwater draft EIS in June 1982. As a result, the option of backfilling the mined-out stopes with tailings has been incorporated into three alternatives. Backfilling could largely eliminate the expression of surface subsidence, in addition to reducing the acreage disturbed by the tailing impoundment. Other methods of mining, such as sublevel long-hole stoping and open pit mining, are not feasible methods of mining the Stillwater Mining Company platinum deposit.

Transportation Methods

The alternative production systems that incorporate the Stratton and Hertzler tailing sites require some form of ore or tailing transportation. Two methods, trucking and slurry transport, have been fitted into the six alternatives. Trucking, in alternative 5, would be the same as first proposed by Anaconda Minerals Company in 1982. Truck haulage is still considered because it provides advantages and disadvantages different from other alternatives and the proposal. The slurry line provides the only feasible alternative to hauling ore by truck. (In the backfill alternatives that use the Stratton and Hertzler tailing sites, slurry transport is the only option possible.) Conveying systems for hauling ore are not considered because they offer no distinct environmental advantage over the slurry line, would be more costly, and would be more difficult to site, owing to the necessity of acquiring some private land.

Mine Portal Arrangements

The increase in the number of mine portals (openings) proposed by Stillwater Mining Company is a major change from the plan first proposed by Anaconda Minerals Company. The two alternatives chosen for analysis in this EIS were based on Stillwater Mining Company's consideration of the optimum number of portals and the agencies' consideration of how to clearly reduce visual impact.

Utilities

Montana Power Company (MPC) is studying three main transmission line alternatives as solutions to the voltage problems that would result from the proposed Stillwater Mine load.

- (1) Convert the existing Laurel-Mystic-Laurel 40-kV transmission line to operate at 69 kV.
- (2) Build a new 100-kV transmission line from the Bridger substation (planned for 1985) to the Stillwater area.

I-20 / Development of Alternatives

- (3) Build a new 161-kV transmission line from the existing Anaconda-Billings 161-kV line to the Stillwater Mine area.

Alternative 1 was dismissed because it would be more costly than either alternatives 2 or 3. Alternative 2 would provide acceptable power for the initial Stillwater Mine load; however, it would not meet unexpected future load demands should either the mine load or residential loads increase. Montana Power Company considers alternative 3 to be the only alternative that would provide acceptable power for the mine load and future load growth in the area. The two alternative 161-kV transmission-line corridors discussed in this EIS are now under study by Montana Power Company.

On-site generation of electricity was chosen as an alternative because it provides a reliable power source without the necessity of constructing a power line.

Road Access to the West Fork of the Stillwater River

The alternative access to the West Fork of the Stillwater trailhead was chosen because it required the purchase of the least amount of private land and would mainly require reconstruction of abandoned roadway.

STILLWATER PROJECT:
PROPOSAL AND ALTERNATIVES

The alternatives covered in this EIS have been divided into four groups: production systems, power-line corridors, mine portal arrangements, and road access routes to the West Fork of the Stillwater River. Each of these groups is described and analyzed separately for clarity in chapters IV and V.

For the first group, production systems, the proposal and six alternative production systems have been developed for analysis. The proposal and alternatives are different arrangements of mining methods, ore transportation methods, mill locations, tailing transportation methods, and tailing impoundment locations.

STILLWATER MINING COMPANY'S PROPOSAL

In Stillwater Mining Company's proposal, mine construction would begin in 1985. The mine would begin producing ore in 1987, yielding an average of 1,000 tons each day. From the ore, the mill would extract 20 tons of concentrate. One truck each day would haul the concentrate to Columbus. A train would haul the concentrate to a smelter for final refining. Left behind would be about 980 tons per day of mill tailings, which would be dumped into an impoundment at the mill site. The operation would last 30 years, including 2 years for construction, 25 years for operation, and 3 years for reclamation. The company would extract about one half troy ounce of platinum-group metals from each ton of ore. (Platinum-group metals include platinum, palladium, iridium, rhodium, ruthenium, and osmium.)

The project would lie within a 550-acre permit area, of which only 165 acres would actually be disturbed by construction and operations (table II-1). The permit area would cover parts of sections 16, 17, 18, 19, 20, and 21 of T5S, R15E (figs. II-1 and II-2). The area lies on both national forest and private (Stillwater Mining Company) land (fig. II-3). The private land would mainly be used for the mill and tailing impoundment, Forest Service land, mainly for the mine. Much of the operation would cover land disturbed by previous mining.

Ore Reserves and Ownership

The ore lies in a geologic zone known as the Stillwater Complex, an igneous rock intrusion about 18,000 feet thick that outcrops for 28 miles in the Bear-tooth Mountains of south-central Montana. Platinum-group metals appear in a layer, or reef, of the complex that is 0 to 20 feet wide. The reef extends nearly continuously along the entire length of the complex. Claims to the complex are held mainly by three companies: Manville Products Company, AMAX, and Anaconda Minerals Company (fig. II-4).

II-2 / Stillwater Mining Company's Proposal

TABLE II-1
Surface Area Disturbance

Facilities	Acres
Mine portals, shaft, and yard area	14
New access road construction	27
Mill, mine support facilities, and tailing impoundment	91
Topsoil storage area	10
Percolation ponds	9
Misc. (tankage, parking, transmission line, etc.)	14
Total Disturbed Area	165
Undisturbed Permit Area	385
Total Permit Area	550

Source: Stillwater Mining Company, 1984a.

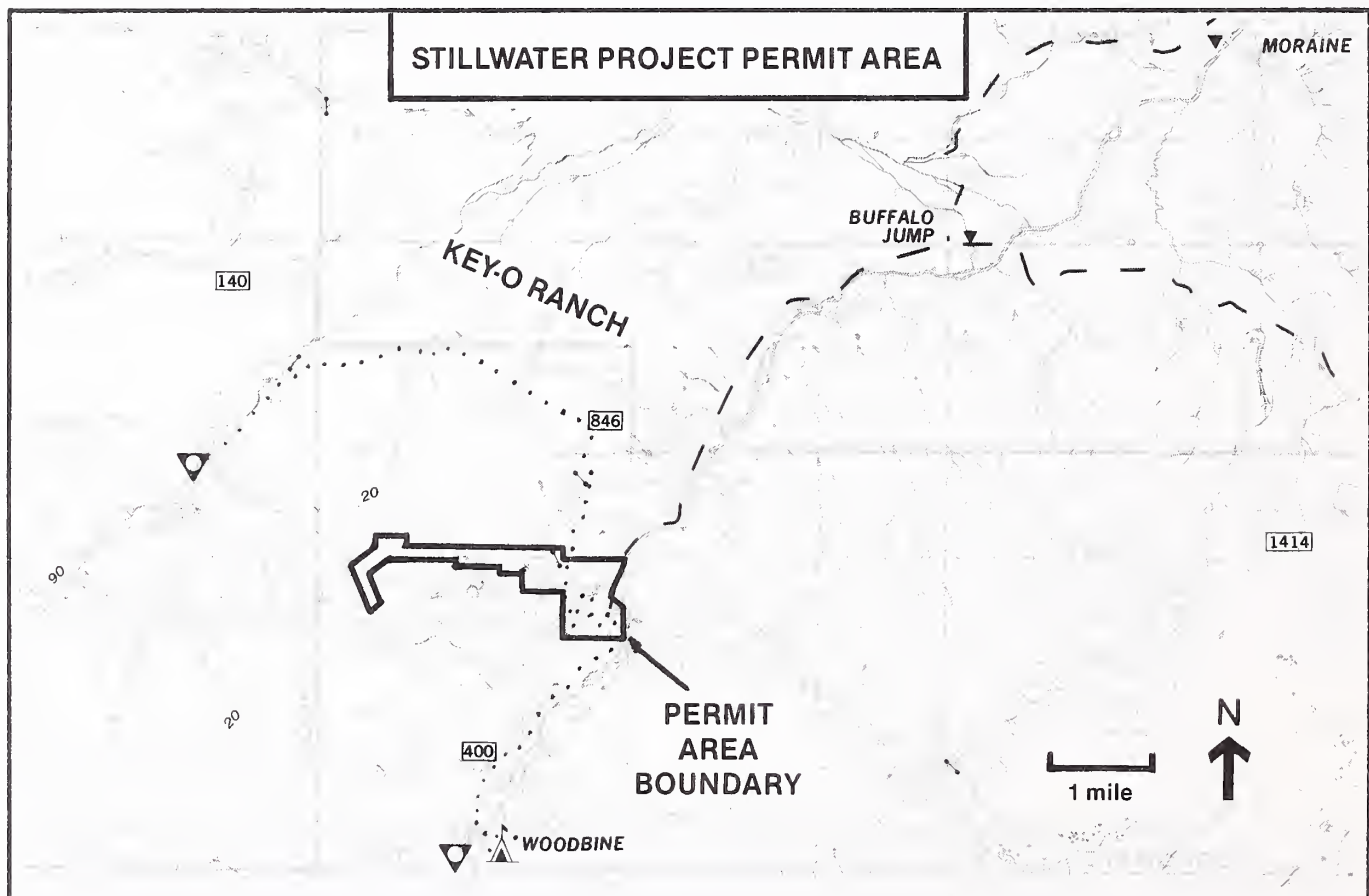


FIGURE II-1

The 550-acre permit area lies near the former Mouat Mine, just north of the Beartooth Ranch and Woodbine Campground. Although the project site is contained entirely within the national forest boundary, much of the permit area lies on private inholdings.

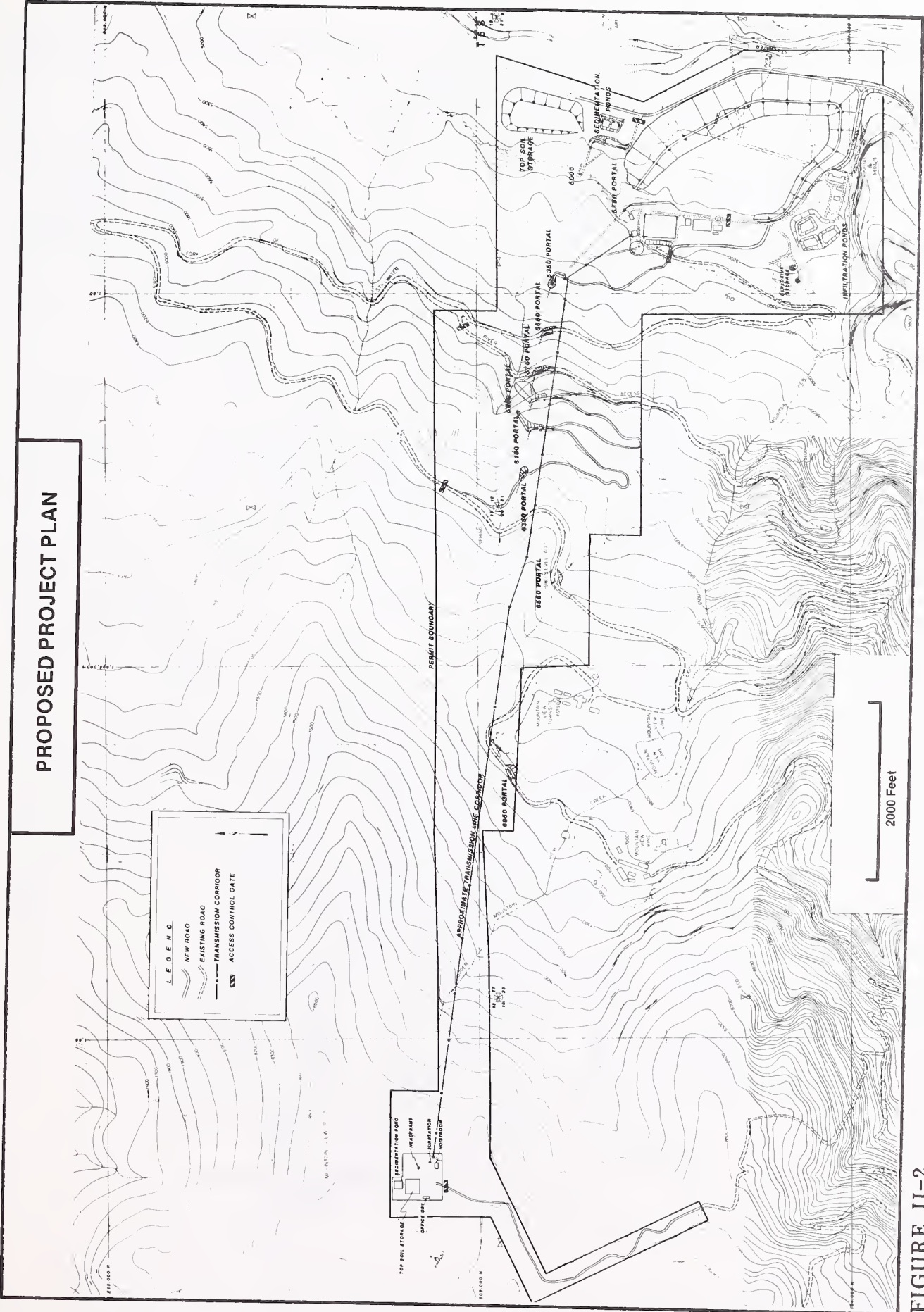


FIGURE II-2

The major components of Stillwater Mining Company's plan include the eleven portals, the 79-acre tailing pond, and the milling facilities. The permit area extends from just west of the Stillwater River to the top of Mountain View Ridge.

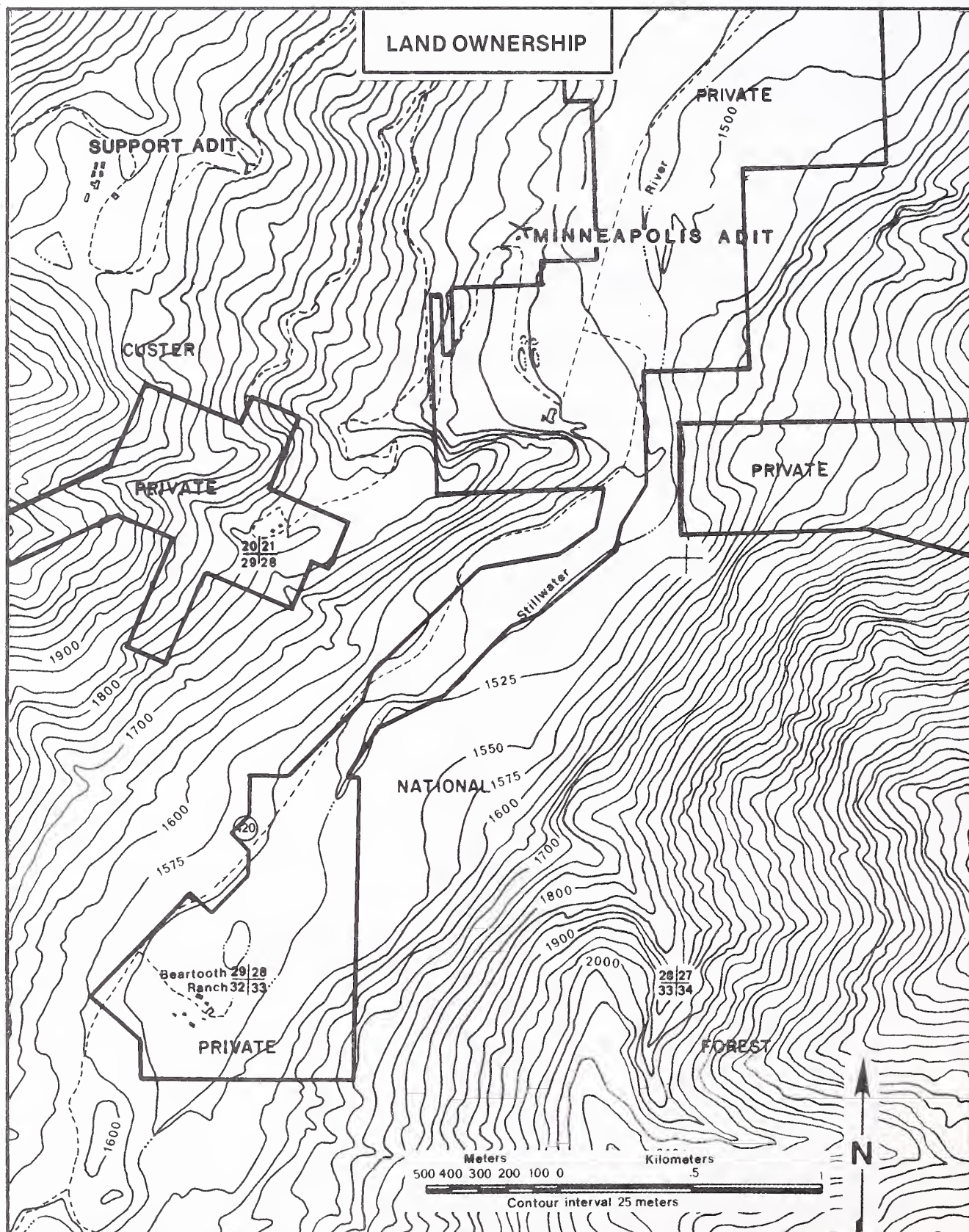


FIGURE II-3

The project would occupy both private and national forest system land. Most of the portals would be on forest land, most of the facilities on private (Stillwater Mining Company) land.

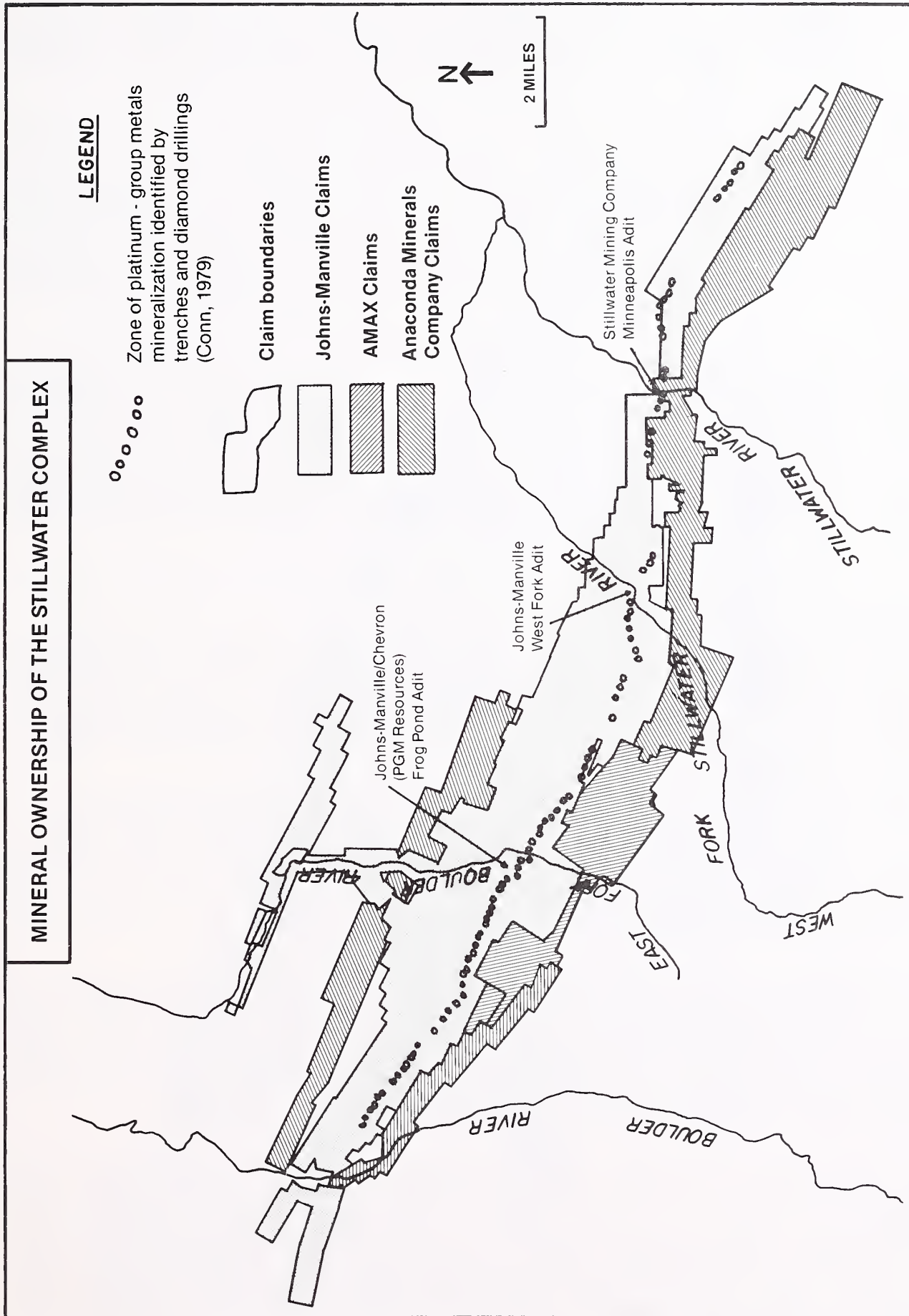


FIGURE II-4

The Stillwater Complex extends for 28 miles across four drainages. Three companies, Manville Products Company, AMAX, and Anaconda Minerals Company, hold most of the claims to the complex.

II-6 / Stillwater Mining Company's Proposal

The complex holds the largest reserve of platinum-group elements known to exist in the United States, an estimated 70 percent of domestic reserves (Dunnet, 1971). According to the National Academy of Sciences, the complex contains more than 125 million troy ounces of platinum-group metals.

The countries that supply most world demand for platinum today are South Africa, the U.S.S.R., and Canada. The Republic of South Africa and the U.S.S.R. together account for 92 percent of world production. Canada produces another 7 percent. South Africa and the U.S.S.R. together possess more than 97 percent of world platinum-group metal reserves (Naldrett and Duke, 1980, p. 1417). The Stillwater Project would supply about 5 percent of the United States demand for platinum and about 20 percent of the demand for palladium (Les Darling, Stillwater Mining Company, pers. com., September 25, 1984).

The single largest use of platinum-group metals is for automobile catalytic converters. The metals are also used as catalysts in the chemical and petroleum refining industry, in electrical components, in jewelry, in medical and dental work, and in a variety of other manufactured goods (Naldrett and Duke, 1980, p. 1417; Jolly, 1978). The need for these metals in a number of industries derives from their high catalytic activity, inertness over a wide range of temperatures, and high melting points--a combination of properties found in no other metals (Jolly, 1978).

Mining Plan

Miners would extract ore by a method called shrinkage stoping. Stoping means the miners would excavate individual chambers, or stopes, in the platinum reef (fig. II-5). The ore would then be dropped through chutes in the stope floor into rail cars in a tunnel below. All ore and waste underground would be hauled by a narrow-gauge rail system.

Shrinkage means that miners would blast ore from the stope ceiling, one layer at a time. The miners would stand on broken ore to set each round of charges. After each blast, enough ore would be drawn through the chutes in the floor to make room for the miners to work (fig. II-6). Some ore would have to be withdrawn after each blast because the volume of the broken ore exceeds the volume of the bedrock by about 40 percent.

When miners set the last charges in each stope, they would be standing on nearly 200 feet of broken ore. After the last blast, all ore would be drawn through the ore chutes, emptying the entire stope. The ceiling of the empty stope would be the floor of the mine tunnel above. Each stope would measure about 200 feet in length, 200 feet in height, and would range in width from 4 feet to 20 feet (average of 6 to 7 feet in width).

By the end of mining, the company would have hollowed out several hundred stopes, converting the ore zone into a one-layer honeycomb 2 miles long, 2,000 feet high and as little as 4 feet thick. The hollows in the honeycomb would be formed not only by the stopes but also by two vertical service shafts drilled to provide access between levels, by 20 horizontal tunnels driven every 200 vertical feet (served by the two shafts and 11 portals), and by many other minor underground chambers, tunnels, and chutes for passing ore, waste rock, men, and equipment.

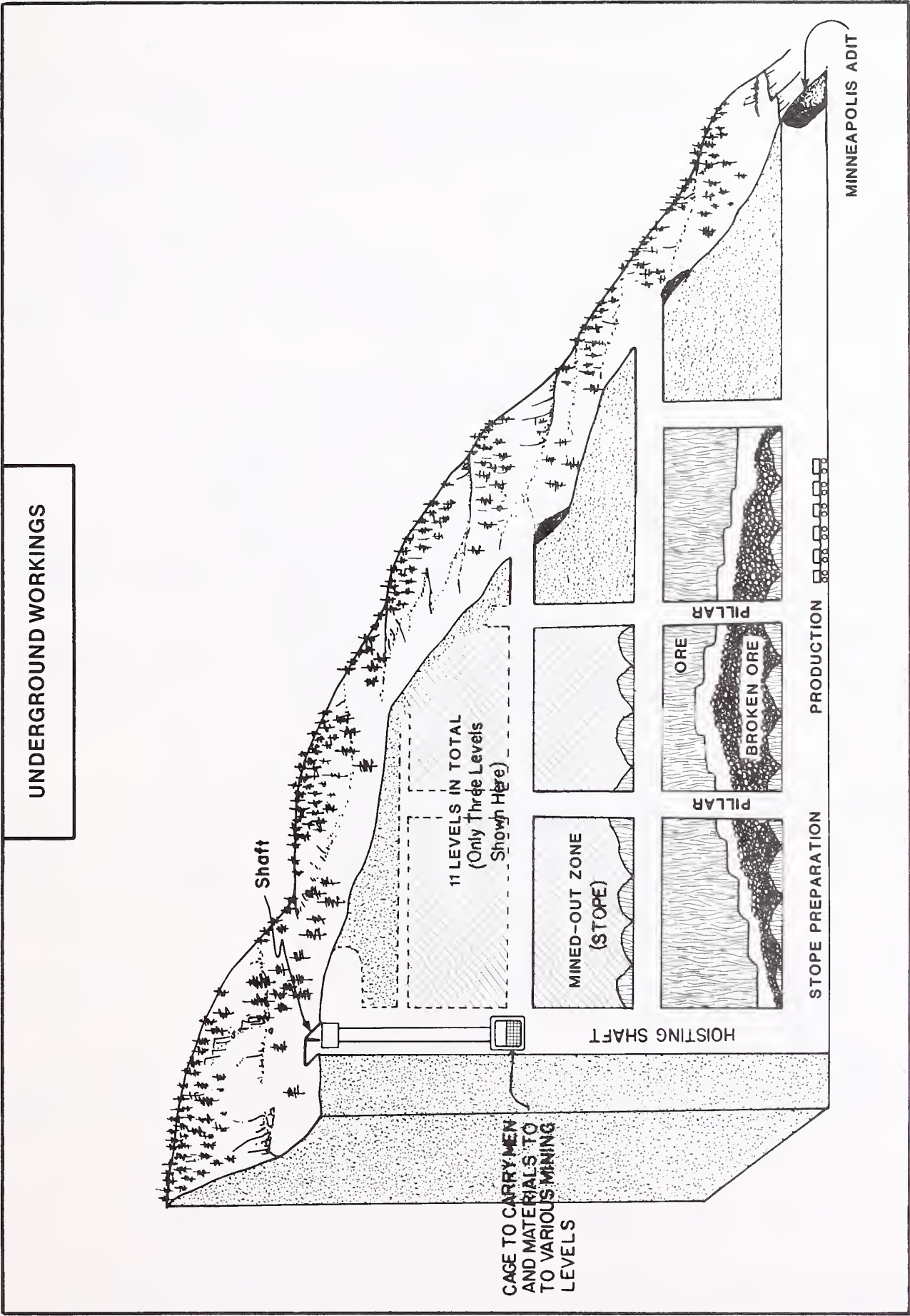


FIGURE II-5

The platinum ore would be mined from a series of individual chambers, or stopes. Along the bottom of each stope there would be a mine tunnel. Eleven tunnels would reach the surface. Although the simplified sketch shows only seven stopes, the mine would eventually have hundreds.

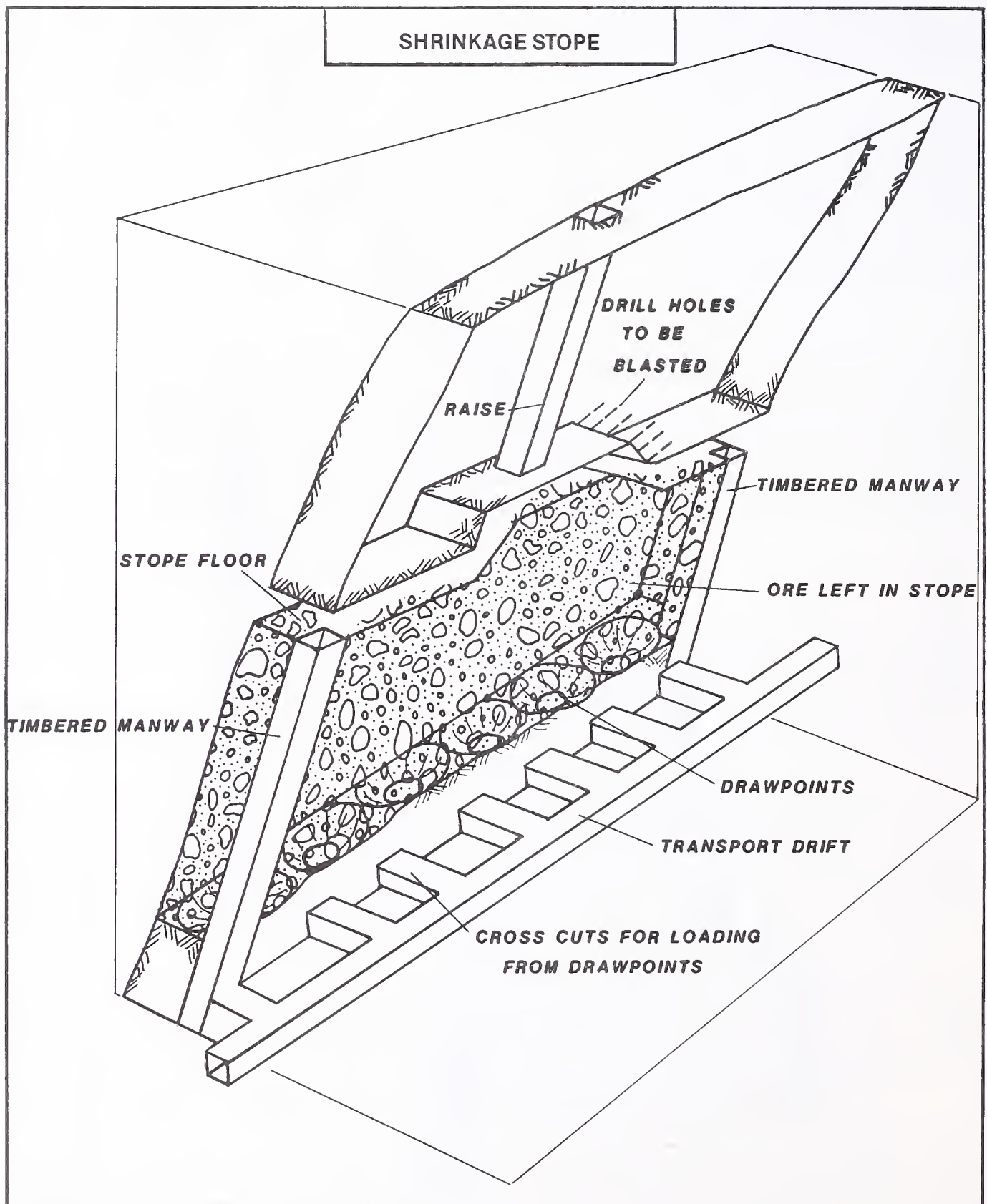


FIGURE II-6

Each stope would be equipped, as the ore rock is removed, with timbered manways. At the bottom of the stope the company would hollow out chutes for dropping ore into railcars in the tunnel below. Each stope would dip, or lean, with the angle of the mineralized zone.

The complexity of the underground workings would not be visible outside the mine. Reaching the surface would be only 11 tunnel portals (including two now used for exploration) and one shaft on the top of Mountain View ridge near the western edge of the mine workings.

The Minneapolis portal (at 5,150 feet) would be the main mine entrance. Most workers and equipment would enter the mine and most ore and waste rock would leave the mine through this portal. The lowest two mine portals (both at 5,000 feet and serving the same tunnel) would be the next busiest area. These portals would provide primary ventilation and water drainage for the mine and an exit for some waste rock and as much as 300 tons per day of ore.

The company would produce about 185 tons of waste rock each day (1,300 tons per week). Three-quarters of this waste would be placed back into empty stopes. The rest would be hauled to the surface for erosion protection, for building the tailing pond dam, and for surfacing yards and roads.

A narrow-gauge railroad would haul both ore and waste rock to the surface. The railroad cars would dump the ore in an underground bin near the Minneapolis portal. A conveyor would then carry the ore through a tunnel to the mill stockpile.

At the lowest portal (5,000 feet), train cars would dump the ore in a stockpile. From there, twenty-five-ton trucks would haul the ore one-half mile around the tailing pond to the mill, using both the public highway (419) and FR 846. Altogether, the ore trucks would make as many as 15 round trips per day.

To prevent surface subsidence, the company would leave a 20- to 50-foot solid rock roof (known as the crown pillar) over the entire honeycombed mine cavity. In addition, the ceiling would be rock bolted to prevent spalling (disintegration by chipping and flaking). If the roof were to collapse and the surface subside, the company would bridge or fill the resulting holes or depressions.

Blasting for the project would be done almost entirely underground. A minor amount of surface blasting would be necessary to build access roads and open the new portals.

The main buildings for the project would be located at the Minneapolis portal (fig. II-7). The facilities would include the mill, warehouse, maintenance shops, offices, ore storage area, electrical substation, waste-water disposal system, compressor building, and explosive storage facility.

The shaft, driven in mine year 12, would be equipped with a headframe, hoist building, and electrical substation. The top eight portals would each have a small service yard, rail tracks, and a steel shed. All project buildings would be painted an earth-tone color.

Although shrinkage stoping has been proposed as the principal mining method, other stoping methods are possible and in fact may be used by the company. It is likely that cut-and-fill stoping or other filled-stope techniques may be necessary to provide adequate ground support and prevent the dilution of ore--a common problem in shrinkage stoping.

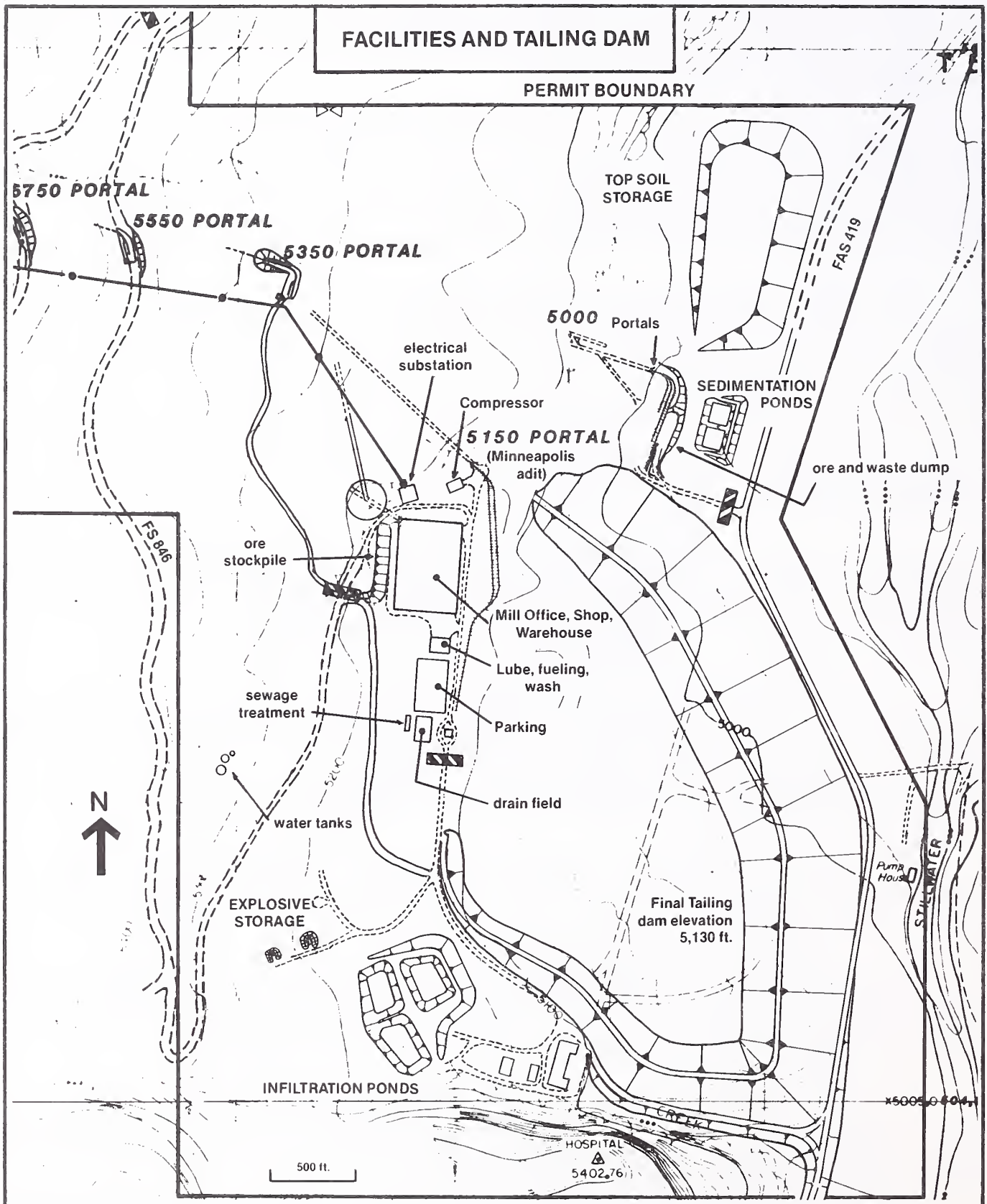


FIGURE II-7

The company would build a facilities complex to process 1,000 tons of ore per day. Over the life of the mine 8.25 million tons of tailings would be discarded in the impoundment.

Milling the Ore

The mill facility would contain a partially enclosed ore storage area, a mill building, a loading area, and several support structures (for water storage, parking, vehicle lubrication, fueling, wash-down).

Milling would consist of crushing, grinding, froth flotation, concentrate drying, and waste disposal. The company would retrieve the ore from the stockpile, grind it, and add water and chemicals to form a slurry of 30 percent solids. This slurry would be subjected to froth flotation, a physical-chemical method of separating and concentrating the metals in finely ground ores. During flotation, the slurry would be agitated, injected with air, and treated with a frothing agent. A froth of bubbles would result. Other chemicals (collectors) added to the slurry would create conditions favorable for the attachment of the desired minerals to the bubbles. The air bubbles would carry the minerals--sulfide minerals in this case--to the surface of a slurry pulp. The mineral-laden froth at the surface of the slurry would be skimmed off, while the other constituents in the ore rock remain submerged. The froth would then be filtered and dried to form a concentrate of precious metals. The pulp slurry left at the bottom of the flotation cells would be piped to the tailing pond for disposal. The froth flotation process would recover over 90 percent of the precious metals in the original ore. The mill would process about 330,000 tons of ore, producing 6,600 tons of concentrate, yearly. The concentrate would be containerized for shipping.

Five chemicals would be used in the milling process: potassium amyl xanthate, polypropylene glycol methyl ether, carboxy methyl cellulose, copper sulfate, and sulfuric acid. (See appendix B.)

The Tailing Pond

The tailing pond would be formed by a hook-shaped dam built of earth and waste rock. The level of the dam would be raised five times over the life of the project (fig. II-8). Into the impoundment the company would eventually dump 8.2 million tons of tailings, discharged as a slurry from spigots along the dam crest. A collection pump mounted on a barge would pipe excess water back to the mill.

During initial construction, the tailing dam would have two parts: the main dam and a 25-foot-high toe dike (fig. II-8). Each time the dam is raised, the company would pile earth and waste rock on the dam crest and slope it toward the toe dike. When the dam is raised the last time, the toe dike would become part of the overall structure. Until then, the dike would catch sediment washing from the dam.

Dam construction would require 3.4 million cubic yards of fill material. Most of the fill would be excavated from within the tailing pond, but some dam material would also be mine waste rock. An impervious liner (hypalon) would cover the pond bottom and embankment to limit seepage. Workers would splice the liner together each time the dam is raised.

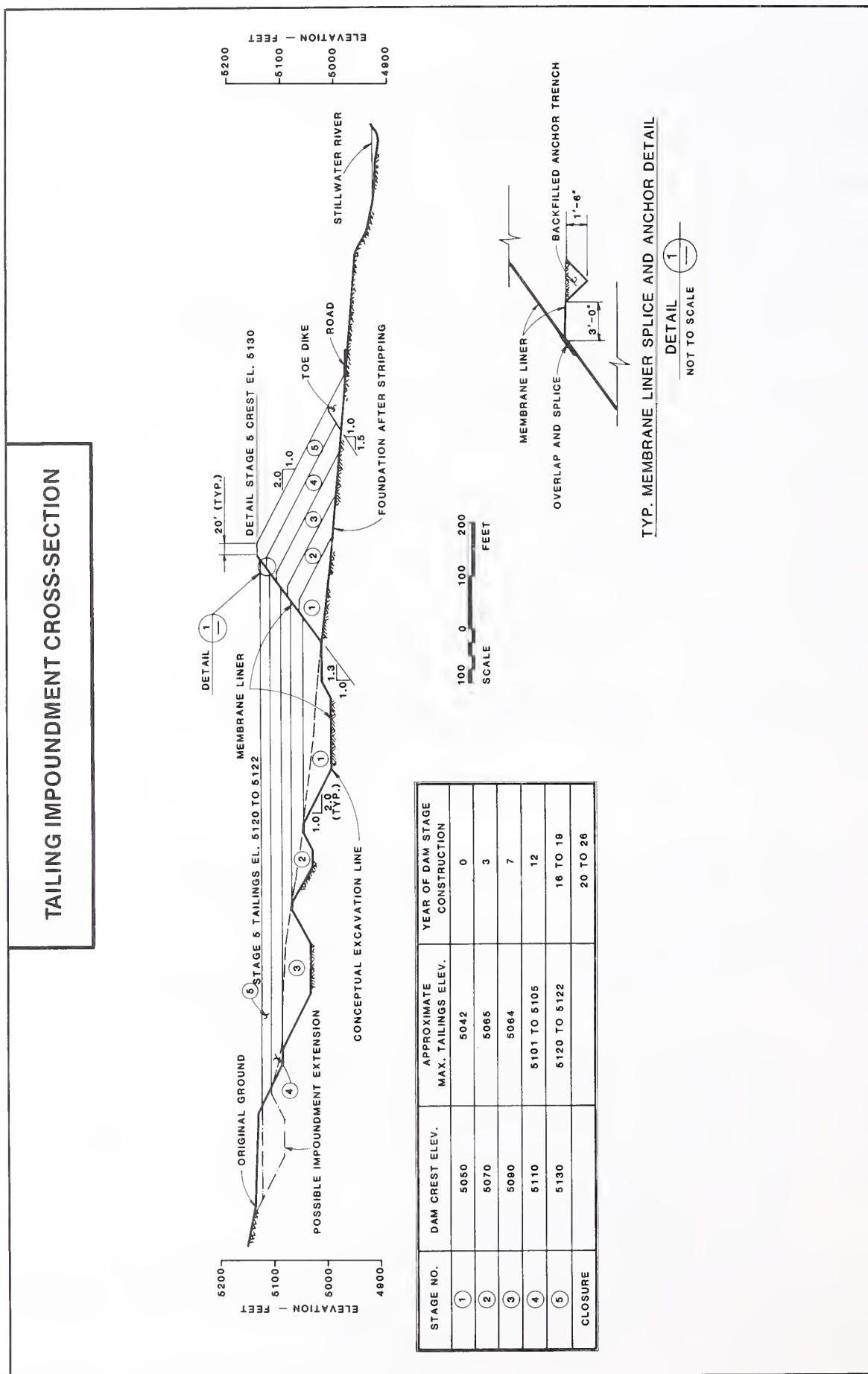


FIGURE II-8

The tailing impoundment dam would be raised five times, approximately every 5 years. The material used in the dam would be borrowed from the impoundment bottom. At the end of mining the dam would rise 160 feet above the highway.

To minimize wind-blown dust, the dam face would be covered with coarse rock, sprayed with water, or revegetated. In addition, the tailing pond would be kept covered with water at all times. The water depth would vary from 1 to 4.7 feet, depending mainly on water use at the mill.

By the end of mining the pond and dam would cover 79 acres. The dam would rise 160 feet above the highway, and the dam face would slope at an angle of 50 percent. During impoundment operation, the dam crest would be 20 feet wide.

Water Management

Water flowing into the underground mine workings would drain to the 5,000-foot level or be pumped to the surface. Pipes would direct some water to the mill, but most would go to the sediment and percolation ponds (fig. II-7). At the ponds the water would either evaporate or seep back into the ground. When in full operation, all excess mine water would leave the underground workings by either the Minneapolis or 5,000-foot-level portals.

The sediment and percolation ponds would be built from earth excavated from the site. The three ponds would together cover about 9 acres and would be capable of handling 500 gallons of water per minute. All three ponds would lie above the 100-year flood plain of the Stillwater River.

At the tailing area, ditches would catch all runoff water and divert it around the dam. For safety, however, the tailing dam would always have enough freeboard (rise high enough above the pond surface) to prevent overtopping. Mountain View Creek would not be affected; it would continue to flow as it does today.

Ordinarily, the mill would require 350 gallons of water per minute. This water would come from the underground mine workings, surface runoff, milling chemicals, precipitation, ore moisture, and water recycled from the pond. Although no additional water is expected to be needed, more could be pumped from wells, which the company plans to drill for drinking water.

Utilities

The entire project would require 6 megawatts of electricity, which the Montana Power Company (MPC) would supply to an electrical substation next to the mill. During mine development and operations, portable generators would be used as necessary to augment the existing 50-kV (kilovolt) system or provide emergency power during supply outages. Stillwater Mining Company's operation, however, would eventually require a reliable power supply. Several alternatives are available. Montana Power Company's proposal is to build a 161-kV transmission line to Nye. As an alternative, Stillwater Mining Company could construct an electrical generation facility at the minesite. These alternatives are discussed in greater detail later in this chapter (Power Alternatives) and are evaluated in chapter V.

II-14 / Stillwater Mining Company's Proposal

Within the proposed permit area, the company would install overhead lines, which would include a 2-mile-long, 13-kilovolt line, running from the substation to the shaft site at the top of Mountain View Ridge. The 13-kV line would require a 20-foot-wide corridor and would supply power both to the mountainside portals and the shaft.

Roads

Two public roads would serve the operation: public highway FAS 419 and FR 846. The highway would provide primary access (fig. II-7) and FR 846 would branch to the mill, surface facilities, and upper portals. FR 846 would remain open to the public and provide access around the operation to national forest lands and Horseman Flats.

The company would relocate three sections of road around the tailing dam: two segments of FR 846 and one segment (about 3,000 feet) of FAS 419. All three segments would be built to Forest Service or county standards. Three more sections of road would have to be built on the mountainside for access by Stillwater Mining Company to the upper portals and shaft. These private roads would have one lane with turnouts and a maximum grade of 10 percent. One portal would lie alongside FR 846; the rest would lie along roads closed to the public. All road improvement and rerouting costs would be paid by Stillwater Mining Company.

Mine Employment

In the first two years, the company and its construction contractor would hire as many as 320 people. The number of employees would decrease in year 3 to 223--25 administrative staff, 155 mine workers, 25 mill workers, and 18 workers to replace those absent because of illness or absenteeism--the permanent work force. Each time the company raises the tailing dam, about every 5 years, it would temporarily hire another 20 to 50 workers.

The administrative staff would work a regular day shift, five days a week. The underground miners would work two shifts a day, five days a week. The mill workers would operate three shifts a day, seven days a week. About 89 workers would be hired locally.

Bonding

Stillwater Mining Company must file a bond with the Department of State Lands of not less than \$200 and not more than \$2,500 for each acre disturbed. Despite these limits, however, the bond must not be less than the estimated cost to the state of reclaiming the disturbed lands (82-4-328(1), MCA). The bond would not be released until the Department of State Lands and the U.S. Forest Service determine that reclamation has been successfully completed.

The Forest Service may require additional bonding if the Service feels that the bond held by the Department of State Lands is not adequate for reclamation of national forest lands or available for Forest Service requirements.

The bond amount would be equal to the estimated cost of stabilizing, rehabilitating, and reclaiming the area of operations on national forest system lands. The bonding level would be adjusted if the plan of operations were modified.

Reclamation

During project construction, the company would reclaim a number of areas:

- o topsoil stockpiles
- o percolation pond embankments
- o diversion ditches
- o tailing toe dike
- o cut-and-fill slopes

The percolation ponds, tailing dam toe, cut-and-fill slopes and drainage ditches would not be disturbed again. The company would have two topsoil stockpiles, one for the tailing area and the other for the Mountain View shaft site. Both would be removed during reclamation.

After project shutdown, all equipment of value would be removed from the underground workings and sold or taken to other operations. The salvaged material would include such items as mine equipment, exhaust fans, and rails. All other material--timbers, rail ties, gates, pipe--would be left in place.

The company would also dismantle and remove all surface buildings and mine equipment, haul away or bury concrete and other debris, and plug the shaft and the highest eight of the eleven portals. The shaft could be plugged with reinforced concrete and the other portals with waste rock. Afterwards, bulldozers would grade the surface. The three portals that are not plugged would be sealed with heavy steel doors secured by hinges and hasps. If the Department of State Lands and U.S. Forest Service determine that the lowest three portals no longer have any beneficial use, these remaining openings would be plugged and reclaimed in the same way as the other portals.

After mining, water would continue to drain from the mine, leaving by the 5,000-foot portal. The percolation ponds would be left to accept the drainage. The company would maintain the ponds until the Department of State Lands and Department of Health and Environmental Sciences determine that direct discharge to the Stillwater River is acceptable.

The parts of FR 846 and the public highway relocated by the company would stay in place after project shutdown. On all other roads, the pavement, if any, would be hauled away. The road surface would then be ripped and recontoured. (Any roads approved for future use by the U.S. Forest Service would be left.)

Tailing pond reclamation would begin with the removal of water from both the pond and from the settled tailings. When the tailings are dry enough to support equipment, bulldozers would reshape the surface, removing the tailing dam crest and grading the entire surface into a mound with a minimum slope of 2 percent, a shape that would shed water (fig. II-9). If the surface subsides

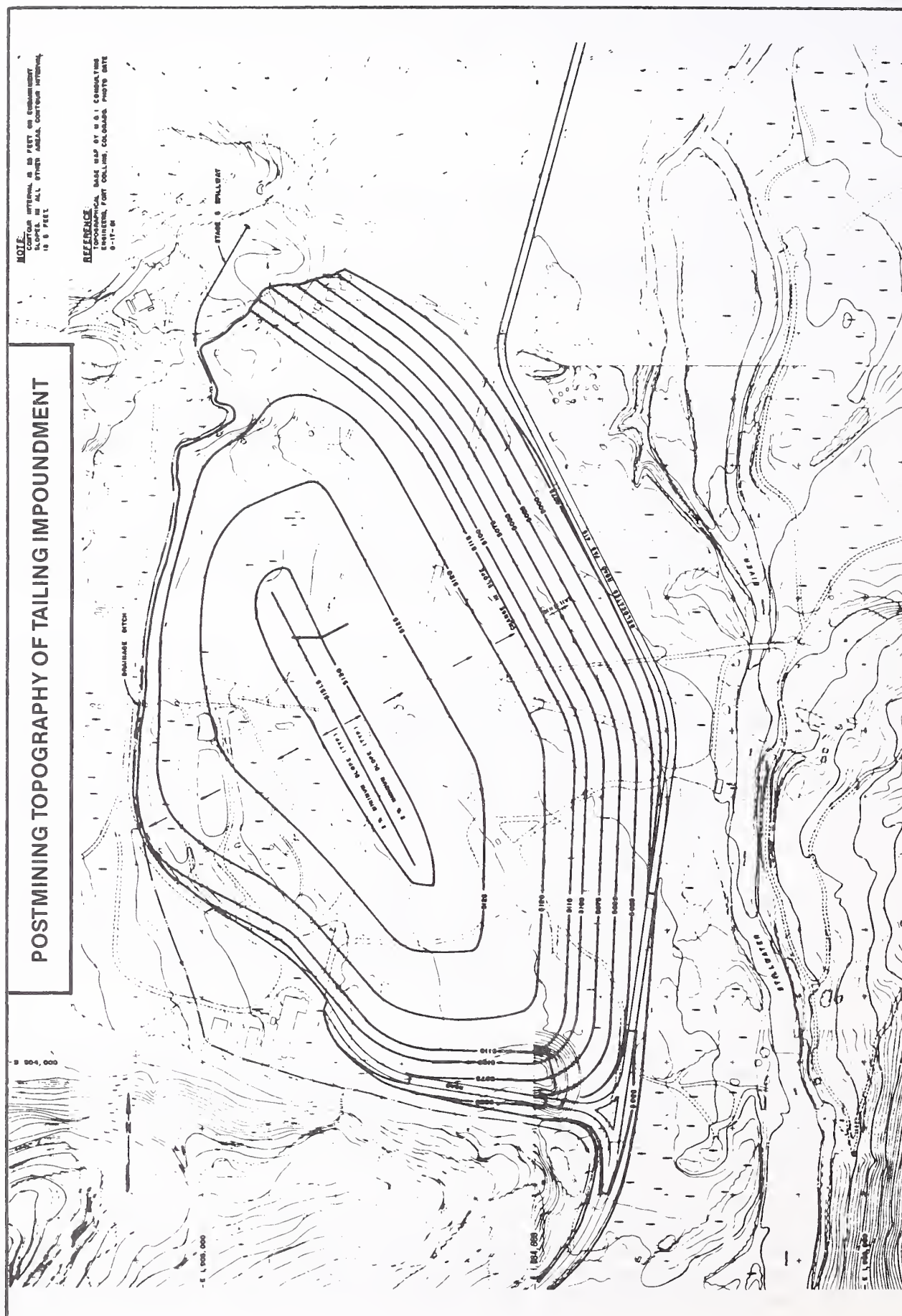


FIGURE II-9

After mining, the company would grade the tailing impoundment into a gently sloping dome. The dam crest would be removed. The company would also remove all milling buildings and support facilities.

from tailing settlement, the low areas would be filled and regraded to prevent puddling of water. The company may cover the impoundment with waste rock to provide a stable surface for reclamation equipment to drive on.

Soil would be spread on all disturbed areas, including the tailing pond, mill site, shaft site, and portal sites. The only exceptions, if approved by the Department of State Lands and U.S. Forest Service, would be portal sites that lie on bare, rocky slopes. The tailing pond would be covered with about 2 to 2.5 feet of soil.

Wherever possible, the company would roll all surfaces with a land imprinter, a steel drum with geometric protrusions that press the soil into a varied pattern of depressions and ridges. The imprinting would help reduce erosion and improve infiltration. The company would plant the surface in early spring (April, May) or late fall (October), primarily with grass seed and tree and shrub seedlings. The company would use one seed mixture for the high elevations and another for the low elevations. Five hundred containerized seedlings per acre would be planted to benefit wildlife and to match nearby plant communities. The woody species planted would come from one of five mixtures, which would vary with the elevation and aspect of the planting site.

To further control erosion, all areas with slopes under 50 percent would be mulched with straw crimped into the soil. On steeper slopes soil-mulch tackifier, hydromulching, or, possibly, netting would be used. The soil would also be fertilized, possibly with 100 pounds per acre of 10-16-0 fertilizer.

The purpose of reclamation would be to reestablish the premining land uses: recreation and wildlife habitat.

Monitoring

Throughout the life of the project, the company would monitor the quality of surface and ground water. Samples of Stillwater River water would be taken and analyzed quarterly from sites both above and below the project. Ground water samples would be taken from four wells on the east side of the tailing impoundment, between the highway and the Stillwater River. The company would also monitor the amount and quality of water leaving the underground mine workings. Water quality monitoring would continue after project shutdown and would last as long as the Department of State Lands and U.S. Forest Service consider the monitoring necessary. Should any water quality problems develop, Stillwater Mining Company would be required to alleviate them.

The tailing dam would be inspected daily for slope instability. The company would also erect and periodically survey monuments placed at the crest of the tailing dam and would install piezometers to monitor ground water levels under the dam foundation.

After project shutdown, the company would monitor revegetation success. Monitoring would continue until the Department of State Lands deems revegetation successful. The degree of success would be evaluated two years after revegetation by comparing reclaimed sites with nearby undisturbed native sites.

PRODUCTION SYSTEM ALTERNATIVES

The proposal contains the following main components:

- o Shrinkage stoping as a mining method
- o The minesite as a mill location
- o The minesite as a location for an 8.2-million-ton tailing impoundment

The production system alternatives have been developed by changing these main components.

Production System Alternative 1

- o Shrinkage stoping with backfill of 3.6 million tons coarse sands
- o Mill at mine
- o 4.6 million ton tailing impoundment at mine

This alternative differs from the proposal in only one main respect: 3.6 million tons of tailings would be pumped back into the empty mine stopes. Backfilling in this way would decrease the volume of the tailing pond to 4.6 million tons. As a result, the impoundment and dam would cover 53 acres and stand about 100 feet high (fig. I-1). Six acres would be required for the soil stockpile.

For the purposes of this analysis of shrinkage stoping with backfill, it will be assumed that a traditional sand-fill technique would be used. In this technique, a cyclone separator isolates the coarse sand fraction from the slime fraction of the tailings. (In the slime fraction, most particles would pass a 200-mesh screen, or be smaller than 0.075 millimeters in diameter.) The sand is carried in a slurry by pipes. In the stopes, partitions stretched with filters hold the slurry in place. As the sand settles, water accumulates on top and is decanted (collected) and drained back out of the mine. A stiffener, such as cement, may have to be added to the backfill.

About half the tailing material can be put back in the mine. The remaining slimes, or fine tailings, would be slurried to the tailing impoundment. Since the tailings leave the mill in the form of a slurry, little if any extra preparation would be required to send the tailings to the impoundment in a pipeline. Backfill would not begin until year 4, after the company has excavated a number of empty stopes. Thus, for the first 3 years, the tailing impoundment would receive all tailings, and as a result, the final impoundment would hold slightly more than half, or 4.6 million tons, of the total 8.2 million tons of tailings.

Reclamation in this alternative would be the same as in the proposal, although the company would have more difficulty removing water from the tailing slimes. The landscape would be restored to the same standard of stability and utility.

Production System Alternative 2

- o Shrinkage stoping
- o Mill at mine
- o Slurry 8.2 million tons of tailings
- o Stratton Ranch tailing site

This alternative differs from the proposal in two ways: the tailing impoundment would be built at the Stratton Ranch and the tailings would be piped to the impoundment in a slurry line.

A tailing slurry is the waste product of the flotation milling method Stillwater Mining Company proposes to use. Slurrying the tailings thus requires little extra preparation (except, perhaps, thickening). The pipe carrying the slurry would measure four inches in diameter. Placed alongside the slurry line would be a 6-inch (lower-pressure) pipe for returning water from the tailing pond to the mill. Both pipes would be buried. For the purposes of this analysis, it is assumed that the slurry line would run in the borrow pit of FAS 419. The line would be 2 miles long, requiring one pump station.

The tailing impoundment would be built in the same way as the one proposed by the company: The dam would be made of earth excavated from the site and the bottom would be covered with a hypalon liner. The tailing dam would be about 125 feet high, and the impoundment and dam would cover about 116 acres. Because the slurry line can be expected to occasionally shut down, an emergency tailing pond would still be required at the minesite. The emergency pond would cover 10 to 15 acres.

Reclamation in this alternative would be the same as in the proposal. The site would be restored to the same standard of stability and utility.

Production System Alternative 3

- o Shrinkage stoping with backfill of 3.6 million tons of coarse sands
- o Mill at mine
- o Slurry 4.6 million tons
- o Stratton Ranch tailing site

This alternative differs from the proposal in three ways. There would be a tailing impoundment at Stratton Ranch and a slurry line to carry tailings--as in alternative 2. In addition, the company would pipe 3.6 million tons of the tailings back into the empty mine stopes, as in alternative 1. The capacity of the tailing pond would be 4.6 million tons.

The tailing impoundment at Stratton Ranch would be built in the same way as the one the company proposes. The dam would be about 82 feet high, and the impoundment and dam would cover 77 acres. Nine acres would be required for a soil stockpile. As in alternative 2, a 10- to 15-acre emergency tailing pond would be required at the minesite. Reclamation would be the same as in the company's plan.

II-20 / Production System Alternatives

Production System Alternative 4

- o Shrinkage stoping
- o Mill at minesite
- o Slurry 8.2 million tons of tailings
- o Hertzler Valley tailing impoundment

This alternative differs from the proposal in two main ways: the tailing impoundment would be built at the Hertzler Ranch and the tailings would be piped to the impoundment in a slurry line. The slurry line would be constructed in the same way as the line to Stratton Ranch, but the Hertzler Ranch line would be longer, about 7 to 9 miles.

For the purposes of this analysis, it is assumed that where the slurry line crosses the West Fork of the Stillwater River, the company would take all reasonable measures to prevent accidental dumping of slurry into the river. For example, the lines would have dual-walled pipes, or be contained in a flume, as an added measure against breaks or leaks. On each side of the river, the company would excavate basins to retain possible leakage.

The tailing impoundment would be constructed by a method different from the one proposed by Stillwater Mining Company. Instead of using earth excavated from the impoundment area, the company would use a cyclone separator to extract the sand from the tailing slurry. The sand would then be used to build the dam. The level of the dam would be raised gradually over the life of the project by what is known as centerline construction. The impoundment would not be lined but instead would have an underdrain system. The dam would eventually reach 108 feet in height. The impoundment and dam would cover about 161 acres. Eighteen acres would be required for a soil stockpile.

As with alternatives 2 and 3, this alternative would require an emergency 10- to 15-acre tailing pond at the minesite. Reclamation would be the same as that proposed by the company.

Production System Alternative 5

- o Shrinkage stoping
- o Truck haulage of ore to mill
- o Mill in Hertzler Valley
- o Hertzler Valley tailing impoundment

This alternative (resembling the 1982 proposal by Anaconda Mineral Company) differs sharply from the proposal. Although the mining method would be the same, the company would transport the ore by truck about 7 miles to Hertzler Valley. The trucks would haul ore 24 hours a day, seven days a week in 20- to 25-ton highway trucks on county roads FAS 419 and 420. It is estimated that 50 to 60 round trips per day would be required. To provide for the heavy truck traffic, the company would repave the entire section of road from the mine to the mill, including upgrading the bridges crossing the West Fork of the Stillwater River.

The 12-acre mill site would be located in Hertzler Valley, next to the tailing impoundment. The impoundment would be constructed in the same way as in alternative 4--by centerline construction with coarse sands cycloned from the tailings.

Reclamation under this alternative would be about the same as proposed by Stillwater Mining Company.

Production System Alternative 6

- o Shrinkage stoping with backfill of 3.6 million tons of coarse sands
- o Mill at mine
- o Slurry 4.6 million tons of tailings
- o Hertzler Valley tailing impoundment

This alternative differs from the proposal in three ways: the tailing impoundment would be built at Hertzler Valley, 3.6 million tons of the tailings would be pumped back into the mine, and the remaining 4.6 million tons of tailings would be piped to the impoundment in a slurry line. As with alternatives 2, 3, and 4, this alternative would require an emergency tailing pond at the minesite. Reclamation under this alternative would be about the same as proposed by Stillwater Mining Company, although the company would have more difficulty removing water from the tailing slimes.

The tailing impoundment dam would be about 85 feet high, and the impoundment and dam would cover 129 acres. Because the coarse sand from the tailings would be deposited in the mine, the company would have to build an earthen dam for the impoundment. The dam would be similar to the one proposed for the minesite, but no liner would be used.

COST ESTIMATES OF PRODUCTION SYSTEM ALTERNATIVES

The cost to build each alternative system depends on two kinds of costs: capital and operating. Capital costs result from facility construction, road building, equipment purchase, and underground development preceding ore production. Capital costs are those that must be defrayed before the project produces revenue. Operating costs result from daily operation of the project: payroll, maintenance fees, electricity bills, periodic equipment replacement. Capital and operating costs must be combined to compare alternatives (table II-2).

The method used here to compare costs employs present value analysis, a technique that accounts for the power of money to grow through investment. Present values represent "discounted dollars," arrived at by calculations that take into account the fact that a dollar earned in the future is less valuable than a dollar earned today. For instance \$1.00 invested at 15 percent is worth \$1.15 in one year and \$1.32 in two years. Discounting reverses this process; an outlay of \$1.32 made two years from now and discounted at 15 percent is worth \$1.00 now.

TABLE II-2

Present Value of Cost Estimates for
Stillwater Project Alternatives
In Millions of 1983 Dollars*

Alternative	Low Range	High Range
Proposal	\$ 7.27	\$ 9.38
1	14.94	16.75
2	8.70	11.57
3	15.58	18.09
4	7.96	10.48
5	4.41	7.97
6	18.58	18.85

*Total costs were discounted at 15 percent to arrive at present value.

Source: Stillwater Mining Company, 1984a, p. A-15;
U.S. Bureau of Mines, 1985, pp. 14-21; Department of
State Lands.

Cost estimates presented in table II-2 are accurate to within 25 to 40 percent. No higher level of accuracy is possible when costs must be estimated from only a rough (conceptual) project plan. Cost estimates are not generally refined until later stages of project development.

The difference in costs among alternatives results from many variations in capital and operating expenditures. Of note is that all alternatives that require tailings backfill (alternatives 2, 3, and 6) would require an additional capital investment and large operating costs--to build a sand plant and pumping system and to backfill tailings. Also of note is that alternative 5, trucking ore to Hertzler Valley, would require relatively lower capital costs. Ore transportation costs in alternative 5 would also be spread out over many years. Other variations in present value costs in table II-2 result from differences in tailing dam construction, slurry line construction costs, and related project requirements.

POWER SUPPLY ALTERNATIVES

Montana Power Company has considered three main transmission line alternatives. One alternative, converting the existing Laurel-Mystic-Laurel 50 kV to 69 kV was considered uneconomical. A second alternative, to build a new 100-kV transmission line from Bridger to the Stillwater area, was considered acceptable, but probably would not be sufficient to meet future load demands. Only the third alternative, construction of a 161-kV transmission line is proposed by Montana Power Company.

Montana Power Company's proposed 161-kV transmission line would be built from the existing Anaconda-Billings 161-kV line, 40 miles to the north, to a

substation at Nye. The existing Benbow-Mouat 50-kV line would connect the substation to the mine. MPC proposes no upgrading of the 50-kV line.

The 161-kV power line would be suspended from 2-pole, wooden, H-frame structures 43 to 70 feet above the ground. The supporting structures would be about 800 feet apart and the line would be at least 25 feet above the ground. The standard right-of-way for a 161-kV line is 80 feet, but this may be reduced to 40 feet in some areas (cultivated land, for example).

Two potential sites for the substation have been chosen. One site is north of the Stillwater River (fig. I-3). With this option, a short section of less than one mile of twin 50-kV lines would be built from the substation across the Stillwater River to connect with the existing Benbow-Mouat 50-kV line. The second site is located south of the Stillwater River (fig. I-3) and would necessitate crossing the river with the 161-kV line.

Before a power line can be constructed, Montana Power Company must obtain a Certificate of Public Need and Environmental Compatibility. An application must be filed with both the Montana Department of Natural Resources and Conservation (DNRC) and the Montana Department of Health and Environmental Sciences. Both the Board of Natural Resources and Conservation and the Board of Health have the power to reject the application. Alternative power-line routes and their associated effects must be studied, especially by DNRC, as prescribed by the Montana Major Facilities Siting Act.

Montana Power Company is currently studying alternative power-line routes and substation locations. Twenty-two power-line routes are being considered within two corridors (fig. I-3). The two corridors are analyzed in this EIS as individual alternatives:

Power Corridor Alternative 1

The 161-kV transmission line would be constructed in a corridor from Big Timber to the Nye substation. Within this corridor, 20 power-line routes are being considered (fig. I-3). The cost of line construction is estimated to be about \$3.9 million.

Power Corridor Alternative 2

The power-line corridor would extend from the existing Anaconda-Billings 161-kV line at Sheep Creek to the Nye substation. Two routes are being examined within this corridor (fig. I-3). The cost of line construction is estimated to be about \$3.7 million.

On-site Generation Alternative 3

Rather than constructing a new power line, Stillwater Mining Company could generate electricity on site. Such a generation facility would probably be an oil-fired 7.4-megawatt turbine generator package. The capital cost is estimated at \$4.8 million and the operating cost is estimated to be \$0.08 per kilowatt hour, compared to the capital and operating costs of \$4 million and \$0.02 to \$0.05 per kilowatt hour for a new transmission line (Stillwater Mining Company, 1984).

MINE PORTAL ALTERNATIVES

Stillwater Mining Company proposes to build one shaft and eleven portals to serve the underground mine workings (fig. II-2). Construction of the portals would require the company to build about 1.4 miles of new roadway on the east side of Mountain View Ridge and construct two miles of 13-kV power line to service the portals and shaft. Two alternatives to Stillwater Mining Company's proposal would reduce the amount of road construction and mountainside surface disturbance.

Mine Portal Alternative 1

In this alternative, the company would use only the shaft and the two existing portals: the Minneapolis portal (5,150 feet) and the 6,550-foot portal. To make up for the lost mountainside access, the company would bore a 14-foot-diameter vertical shaft inside the mine to serve all mine levels. Similar to the proposal, a 13-kV power line would be constructed to service the portals and shaft.

Except for the shaft, the underground operations would remain generally the same as in the proposal. However, the shaft would require that the company drive a new portal at the 6,550 level and improve the access road to that level. The shaft would also require an additional 2 years of development work since the entire shaft would have to be finished before work could begin at any level in the mine. The total development time for this alternative would be 6.5 years, compared to the 4.5 years for the proposal.

Mine Portal Alternative 2

In this alternative, the company would mine as proposed, but would eliminate three portals: the 5,950-, 6,150-, and 6,350-level portals. The company would have to either drive an internal 14-foot-diameter shaft, the same as in alternative 1, or excavate a ramp and drive a 7-foot-diameter shaft. A 13-kV power line, as in the proposal and alternative 1, would be constructed to service the portals and shaft.

The underground mine operation would remain generally the same as in the proposed operation. If a ramp were built, however, the company would have to use rubber-tired machinery in addition to tracked equipment. The development time for either the ramp or shaft variation of alternative 2 would be the same as for the proposal: 4.5 years.

CAPITAL COSTS OF MINE PORTAL ALTERNATIVES

Table II-3 presents the capital cost estimates for the different portal arrangements. The costs are in current dollars and are not discounted as are the costs in table II-2. These cost estimates are accurate to within 25 to 40 percent.

TABLE II-3

Comparison of Capital Costs for
Surface Disturbance Alternatives
In Millions of 1983 Dollars

Alternative	Low Range	High Range
Proposal	\$3.6	\$5.0
1	5.0	12.3
2 (ramp)	4.4	6.0
2 (shaft)	5.3	13.4

Source: Stillwater Mining Company, 1984a, p. 10; U.S. Bureau of Mines, 1985, p. 4.

ALTERNATIVE ROUTES TO THE WEST FORK OF THE STILLWATER RIVER

Stillwater Mining Company's Proposal

Under the proposal, FR 846 would continue to provide the public access to the West Fork of the Stillwater River (figs. I-2 and I-4). FR 846 would be relocated for one-half mile, starting from FAS 419. The relocation would place the road at the toe of the tailing pond dam and along Mountain View Creek. The relocation would direct traffic around the west side of the mine buildings, where the road would connect with the existing FR 846. Gates would be constructed on FR 846 in three locations to keep the public from entering the mine complex.

West Fork Road Alternative

An alternative access road to the West Fork of the Stillwater could be built by reconstructing a one-mile abandoned road between the Picket Pin Road and FR 846 west of Horseman Flats (fig. I-4). A single-lane bridge would have to be constructed over the West Fork of the Stillwater River to connect FR 846 with the reconstructed road. Some private land would have to be purchased for the right-of-way. Approximately 2 miles of FR 846, starting where it leaves FAS 419, would be closed to the public and used exclusively by Stillwater Mining Company. Another mile would be closed to all traffic and rehabilitated. Although FR 846 from FAS 419 to the company's mountainside portals would be closed to the public, the Forest Service would retain its right-of-way.

The cost for this alternative would amount to approximately \$150,000: Right-of-way acquisition is estimated at \$10,000, bridge construction at \$100,000, and road construction at \$40,000. The company would pay all these costs. If the bridge were to be constructed to double-lane standards, the

II-26 / Alternative Routes to the West Fork of the Stillwater River

total cost would increase to \$200,000. The bridge and road would be built to Forest Service standards. The company would be required to reclaim the section of FR 846 from the turnoff for the upper portals to the east end of Horseman Flats.

DESCRIPTION OF AFFECTED ENVIRONMENT

An analysis of Stillwater Mining Company's proposal requires that the EIS cover 19 topics, representing the "environment" of the Stillwater Project today. This environment encompasses the resources, enterprises, services, facilities, and people that could be affected by the company's new mine.

The selection of EIS topics was guided by public and government agency concerns. Analysts from the Department of State Lands and the U.S. Forest Service compiled the issues they felt were important. The public added its concerns through letters and a public meeting. (See Introduction.)

The topics analyzed generally include information on only those parts of the environment that could be affected, directly or indirectly, by the project. For the sake of brevity, the parts of the environment that are not expected to be affected have not been discussed.

Note that the chapter not only describes the condition of the social, economic and natural environment today, but also the condition this environment would be in if the Stillwater Project never opened. This means the chapter does contain projections of the future--but a future without the mine. Chapter IV goes on to predict the future with the project.

GEOLOGY

General Geology--Stillwater Complex

The platinum-group metals that Stillwater Mining Company is considering mining are part of the Stillwater Complex (fig. III-1). The complex is 1 to 5 miles wide and 28 miles long, crossing the Boulder and Stillwater River valleys. The complex originated as a molten magma intrusion. The original intrusion contained iron, nickel, copper and platinum-group metals which settled out at different levels as the molten mass crystalized deep within the earth. Mountain building forces that created the Rocky Mountains brought a large block of this intrusion (the Stillwater Complex) to the surface. This type of deep intrusion exposed at the surface of the earth is rare. Because of its unusual geologic character and because of the metals associated with it, the Stillwater Complex has been investigated by numerous researchers (Howland et al., 1936; Wimmeler 1948; Jones et al., 1960; Jackson, 1968; Page, 1977; Raedeke, 1979; Conn, 1979).

Platinum-group metals occur in several layers of the Stillwater Complex. The layer of highest concentration is only 3 to 15 feet wide. This narrow zone is nearly continuous and appears to extend the entire length of the complex (fig. III-1). Nickel-copper and chromite deposits are also present throughout the complex, but are less continuous, occurring as scattered, isolated pockets.

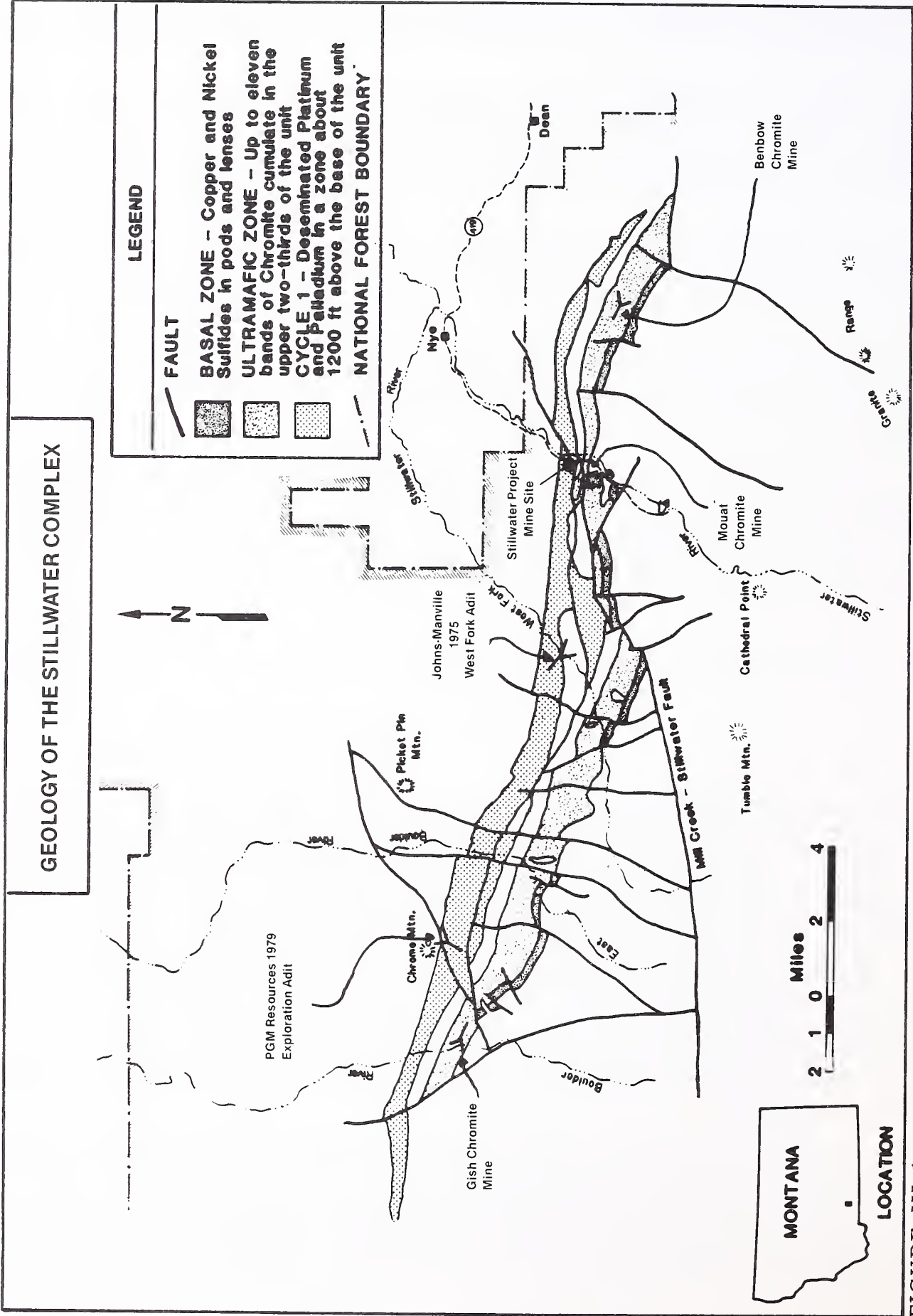


FIGURE III-1

Although the Stillwater Complex is 1 to 5 miles wide, the zone of highest platinum mineralization reaches a maximum width of only 20 feet. The complex contains an estimated 70 percent of U.S. platinum reserves. Other metals in the complex include chromite, copper, and nickel.

Historical Mining in the Stillwater Complex

Chromite

Interest in ore within the Stillwater Complex first developed during World War I, but it wasn't until World War II that ore was actually produced. In 1941 Anaconda Copper Company received a subsidized contract with the U.S. Government and began underground development at three separate sites along the Stillwater Complex: (1) the Benbow area; (2) the Mountain View area, 6 miles southwest of Nye; and (3) the Gish area. (See fig. III-1.) The Anaconda Company produced about 71,500 long tons of concentrate from the Benbow area, averaging about 42 percent chromite, and 26,000 tons of concentrate (averaging about 34 percent chromite) from the Mouat Mine. All operations stopped in 1943 because high-grade chromite was again available from overseas sources (Read, 1977).

From 1953 to 1961 the American Chrome Company, under another U.S. Government-subsidized contract, produced 900,000 tons of chromite concentrate from the Mouat Mine. Some of this was stockpiled near Stillwater Mining Company's present mine headquarters building for strategic purposes. In the early 1970s, the U.S. government sold the chromite stockpile to a private company, which has since removed all chromite from the site. A large stockpile of chromite still exists next to the railroad in Columbus.

An estimated 70 percent of domestic reserves of chromite ore remain in the Stillwater Complex. All of this ore is of the high-iron, low-chromium variety, only marginally suitable for stainless steel production. Further advances in chromium-ferro alloying could make these deposits economic (Read, 1977, p. 12).

Copper and Nickel

As early as 1936 the Stillwater Complex was recognized as a possible source of other metals besides chromite, including copper, nickel and platinum-group metals. As yet, none of these metals have been produced in commercial quantities. The Stillwater Complex contains what is believed to be the second largest nickel resource in the United States. Even so, the nickel and copper concentrate of the Stillwater deposits is not rich enough at current prices to justify nickel and copper development; higher grade ore is readily available elsewhere.

Three companies own the largest blocks of copper-nickel deposits within the complex. They are the Anaconda Minerals Company, AMAX, and Cyprus Mines. Individuals and the Monta Vista Corporation of Billings own smaller portions.

Platinum-group Metals

When the demand for and price of platinum-group metals drastically increased in the late 1960s and early 1970s, exploration for these metals began in the Stillwater Complex. Johns-Manville Sales Corporation, which initiated exploration work in the Stillwater Complex in 1967, identified four zones

III-4 / Geology

with high platinum-group metal values. One of these was found to be nearly continuous for about 24 miles of the 28-mile-long Stillwater Complex. As a result, the company filed claims on a large portion of the complex (fig. II-3).

Johns-Manville initiated underground exploration in the north wall (6,500-foot elevation) of the West Fork of the Stillwater River (fig. II-3). The average grade was 14.7 parts per million total precious metals, which compares favorably with total metal values now produced in the Merensky Reef/Bushveld complex of South Africa, the major world supplier of platinum-group metals. Nonetheless, Johns-Manville had to abandon this operation in 1976 because water under very high pressure was encountered in the adit.

In 1979 Johns-Manville, in partnership with Chevron USA, began development of a second exploration (Frog Pond) adit farther west in the Stillwater Complex. Exploration work and project engineering assessment for this project proceeded until 1983, when the Stillwater Mining Company was formed.

Anaconda has owned the mineral rights to the area around the old Mouat Chromite Mine since the 1940s. In 1977 Anaconda mapped its properties, identifying the same zone of platinum-palladium mineralization that Johns Manville had claimed over most of the complex. In mid-1979 the company began construction of the Minneapolis adit and by late December reached the mineralized zone. Exploration work has continued since. (See chapter II.)

General Geology of the Minesite (Proposal and Alternative 1)

Topography and Geomorphology

The existing exploration adit is located one-quarter mile west of the Stillwater River at the base of the steep side slope of the valley (fig. III-2). The topography climbs at less than a 10 percent grade from the river up to the adit, then quickly steepens to a grade averaging about 25 percent. Farther upslope, within one half mile of the river, the landscape again flattens, to less than 8 percent. Here, Mountain View Lake lies in a depression on landslide deposits on the side of the mountain. Several small streams near the mine flow from the steep mountainside, emptying into the Stillwater River. Mountain View Creek flows from Mountain View Lake, emptying into the Stillwater River along the southern boundary of the minesite (fig. III-2).

Surficial Geology

Three general types of unconsolidated deposits exist at the minesite: alluvium (stream-laid deposits), colluvium (gravity-controlled deposits) and ancient mass-movement deposits. Two large landslides cover much of the slope above the minesite and at one time probably extended across the entire valley. These large slope failures probably occurred over 10,000 years ago, during one of the several recent glacial periods in North America's geologic past. The thickest and lowest portion of the main landslide was subsequently removed by



FIGURE III-2

The project site rises steeply from the head of the Stillwater Valley to the top of Mountain View ridge. The only gentle topography lies in the valley bottom and around Mountain View Lake.

III-6 / Geology

the Stillwater River. Alluvial and colluvial deposits, including an alluvial fan of Mountain View Creek, then covered much of the lower parts of the landslide. Landslide deposits are known to exist under the alluvium at the old hospital (mine headquarters) and percolation pond area because landslide debris was encountered in several drill holes and test pits dug at the site.

Bedrock Geology

The Stillwater Complex cuts across the Stillwater River Valley at nearly a right angle (fig. III-1). The complex extends two directions from the mine--roughly due east into Nye Basin and west for about 25 miles into the Boulder River Valley. Near the minesite, the rocks of the complex are exposed over a 1.5- to 2-mile-wide band. The layers of the complex dive steeply under the surface toward the north at about 50 to 80 degrees (measured down from a horizontal plane).

Structural Geology

The mineralized area around the company's proposed mine and mill facilities has several large faults that offset the bedrock units (fig. III-3). The east-west trending South Prairie Fault passes just north of the Minneapolis adit. This fault appears to have offset some of the platinum-group mineralized zone, slightly reducing the amount of ore reserves (Jim Harrower, Anaconda Minerals Company, oral com., February 1982). The fault is at least 5 miles long.

Another east-west trending fault, called the Lake Fault, passes through the proposed permit area. It appears to extend across the Stillwater River Valley into the Nye Basin. The length of this fault is unknown. The inferred Stillwater Valley Fault is not visible because river deposits cover it. Its presence is indicated by offset geologic units on opposite sides of the valley. The length and continuity of this fault are unknown.

Most of the major movement along faults near the minesite occurred during the mountain building processes that formed the Rocky Mountains from 145 to 69 million years ago.

Geologic Hazards

Geologic hazards are natural conditions that could lead to damage of property or danger to human safety.

Earthquakes. Based on earthquake locations documented over the last 30 years, the Stillwater River area appears to have low earthquake activity. Areas within 100 miles are earthquake prone and have caused moderate ground shaking within the valley. The Hebgen Lake-Yellowstone Park area is one of the most active earthquake areas in the Rocky Mountains. The 1959 Hebgen Lake earthquake, measuring 7.1 on the Richter scale, caused ground shaking at Nye strong enough to break one water main, break dishes, crack foundations, and

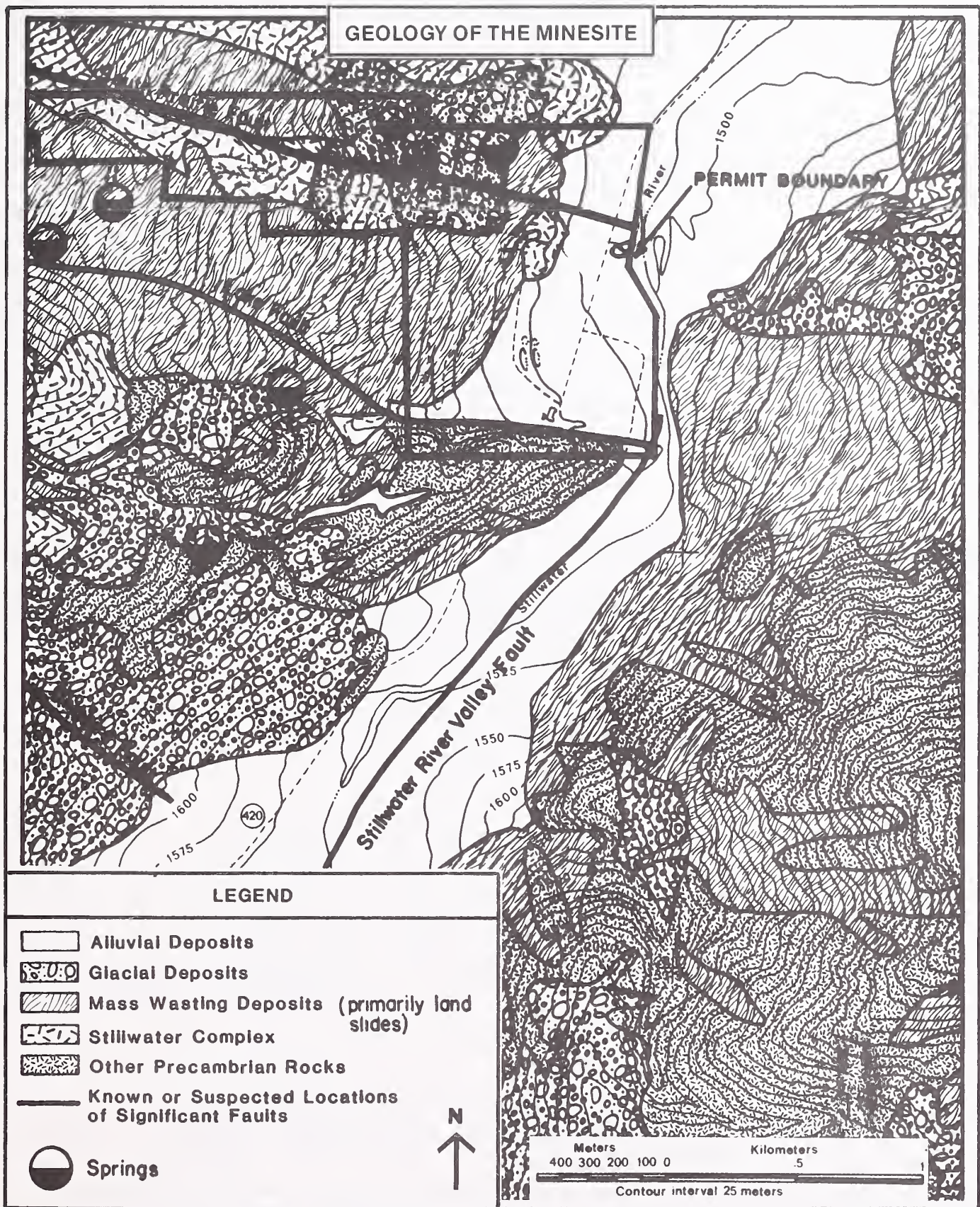


FIGURE III-3

Two large landslides cover the mountainside on which Stillwater Mining Company would bore new mine portals and build new access roads. The facilities and tailing impoundment would be constructed mostly on alluvial (stream-laid) deposits.

cause several rockfalls (modified Mercalli Intensity VI). This event is estimated to have produced peak ground accelerations of about 10 percent of gravity near Nye. The Hebgen Lake-Yellowstone Park area is the most likely area to cause ground shaking in the Stillwater River Valley in the future.

The nearest suspected active fault large enough to cause damage in the Stillwater Valley is the Emigrant Fault in the Yellowstone River Valley, about 32 miles west of the study area. The Emigrant Fault reportedly cuts recent (Pleistocene) surficial deposits, indicating that it is probably still active (Wetkind, 1975). One recorded earthquake, measuring 4.2 magnitude (Richter scale), occurred in 1965 in the general vicinity of the Emigrant Fault (Camp Dresser and McKee, [CDM] 1981, p. 2.7-51). Although no concrete evidence is available, the offset in recent surficial deposits point to the Emigrant Fault as the probable source of the earthquake. The fault is capable of producing up to a maximum magnitude-7 earthquake because of its long length. A magnitude 7 earthquake, although very unlikely, could trigger large rockfalls or landslides, cause chimneys to break and fall, crack roads and bridges, and crack concrete foundations in the Stillwater River Valley. It could produce peak accelerations of about 17 percent of gravity in the Stillwater Valley.

Recent movement along local, small-scale faults has been reported next to the project area in the following locations: near Little Rocky Creek, on the south slope of Contact Mountain, and to the north of Chrome Mountain. These small faults would be capable of producing only small earthquakes. One recorded earthquake, magnitude 4.0, occurred along the Beartooth front in 1965, indicating that the Beartooth Mountains are not totally inactive. The exact location of the quake is unknown. None of the larger faults within the area exhibit any evidence of recent movement (CDM, 1981).

Avalanches. There are numerous avalanche tracks on the steep slopes on both sides of the Stillwater River near SMC's permit area, but the site itself is not within an identified avalanche corridor.

Slope failures. Slope failures ranging in size from small slumps to large landslides are present throughout the Stillwater Valley. Most of the failures occurred during past ice age advances, which ended roughly 10,000 years ago. The landslides most often occurred in unconsolidated surficial deposits, including lateral moraines, but also developed in highly weathered bedrock. The wetness of the ice ages probably contributed to slope instability by saturating the surficial deposits. Slope steepening resulting from the cutting of a large glacier may also have contributed to the numerous slope failures. The glacier also provided lateral support for the moraines; after the ice melted, the support was removed and the moraine materials probably slid.

Earthquakes causing ground shaking and postglacial stream downcutting may also have triggered some of the slides. Most of these slides are now well drained and are probably stable; however, some of the slides do have small ponds, bogs, and springs within them. Because water acts to lubricate and buoy, decreasing particle cohesion, these saturated areas may be potentially unstable.

In June 1975, one small landslide occurred beside the West Fork of the Stillwater River near where Johns Manville was doing exploration work on the West Fork adit (fig. III-2). The occurrence of this landslide indicates that landslides in the region can happen when unstable material on steep slopes becomes saturated. In 1975 the snowpack was much deeper than usual in the month of June. Heavier than usual rainfall also occurred. The shale and glacial material became saturated and failed. Johns Manville's activities near the slide probably were not a factor in causing this landslide (D.C. MacIntyre, Forest Supervisor, Custer National Forest letter to Miles Keogh, Nye, Montana, September 16, 1977).

Two landslides exist within and upslope of the company's proposed mine/mill complex (fig. III-3). The boundaries of these landslides are probably somewhat larger than indicated on the map, especially downslope of the larger landslide. Landslide deposits associated with the largest landslide were encountered in drill holes and excavation work beneath Stillwater River terrace deposits near the existing percolation ponds. This old landslide extended well into the Stillwater Valley and may at one time have temporarily dammed the river (Robert Hinshaw and Larry Prinkki, U.S. Forest Service, Region I, Geotechnical and Field Investigation staff, written com. to Director of Engineering, December 15, 1981).

Despite considerable human activity (road construction, blasting, tunnel development) in and around these two landslides, they have not moved to any discernible degree. Even the strong ground shaking caused by the 1959 Hebgen Lake earthquake did not cause ground failures at the site. Even so, the largest landslide does have characteristics that are important to note: (1) much of the toe of the landslide has now been removed by the Stillwater River or by glaciers--the material resting upslope has therefore lost some support; (2) the landslide is more than 400 feet thick in its middle section; (3) SMC's adit development trend parallels the steepest, and probably the most unstable, part of the large landslide, and (4) several springs originate from the larger landslide, which also contains Mountain View Lake.

The existing upper support adit (6,550-foot level) is located within the edge of the larger landslide. The support tunnel was driven through 440 feet of landslide debris. The landslide material ranges from sand-size particles to boulders several feet in diameter. Anaconda Minerals Company had to use massive metal beams to support the upper support tunnel. Although construction methods included blasting, no movement has been identified in the landslide (Hinshaw and Prinkki, 1981).

Preliminary field investigations done by Forest Service personnel determined that these two landslides appear to be fairly stable and have low probability of failure (Hinshaw and Prinkki, 1981). Even so, because of the above-mentioned conditions, the possibility of these materials failing again cannot be totally ruled out. (See chapter IV, Geology, Geologic Hazards.)

Besides the known landslides, many of the geologic units within the upper Stillwater Valley were mapped as potentially unstable slopes by the geologic consultant hired by Anaconda. These areas have characteristics similar to areas that have failed. Natural environmental variables (erosion, earthquakes, moisture increases, and weathering) along with changes induced by man

III-10 / Geology

are considered to be the most important factors influencing the stability of potentially unstable slopes and the existing landslides. (See chapter IV, Geology, Geologic Hazards.)

Geology of the Stratton Ranch Site (Alternatives 2 & 3)

The Stratton Ranch site is similar in many respects to the minesite. Sedimentary bedrock lies along the southern and southwestern margins of the impoundment site. These strata have been upturned and now dip steeply to the north. Resistant Madison limestone forms a prominent ridge that extends about a third of the way across the Stillwater Valley along the southern edge of the site.

Unconsolidated deposits cover the majority of the site. These include Stillwater River terrace deposits, alluvial fan deposits of a small tributary creek, and landslide deposits. The Stillwater River terrace deposits are over 100 feet thick. Upwards of 60 feet of alluvial fan deposits interfinger with the Stillwater terrace deposits in the southwestern corner of the site. Landslide deposits exist along the north-northeastern margins of the site. The landslide deposit covers about a square mile and is over 53 feet thick. Prominent slump scarps exist at the upper edge of the landslide. The landslide probably occurred during or soon after the last glacial advance, roughly 10,000 years ago.

Geology of the Hertzler Valley Site (Alternatives 4, 5, and 6)

Anaconda Minerals Company originally proposed to locate the mill and tailing pond in a small north-facing tributary valley to the Hertzler Valley (now an alternative to Stillwater Mining Company's proposal). The Hertzler Valley is a tributary to the Stillwater River. The valley is just over 2 miles long and drops from 4,900 feet at its western end to 4,680 feet where it enters the Stillwater River. Bush mountain, elevation 5,300 feet, separates the Hertzler site from the Stillwater Valley.

The small tributary that would be filled with tailings at this site is about one mile long and drains to the north. The upper end of this tributary drainage starts at an elevation of 4,940 feet and drops to about 4,820 feet, where it enters the valley.

Surficial Geology

The entire Hertzler Valley is covered by coalesced alluvial fan deposits from side tributary drainages. These fan deposits vary in thickness depending on their proximity to the contributing tributary. The fan deposits cover older glacial outwash material. The outwash deposits are more than 80 feet thick in the middle of the valley.

The Hertzler site itself is entirely covered with glacial deposits. The deposits are composed of pebble- to boulder-size fragments up to 50 feet

(average less than 5 feet) in diameter in a matrix of clayey, silty sand (CDM, 1981, p. 2.7-16). The thickness of the glacial deposits varies and is not well known.

Bedrock Geology

The Colorado and Montana group sedimentary rocks are the two uppermost sedimentary bedrock units underlying the Hertzler Valley. The Colorado group rocks, the deepest bedrock units identified in the valley, are composed mostly of shale with smaller horizons of interbedded sandstone. The total thickness of the Colorado group rocks is between 2,300 and 3,300 feet. The Montana group, overlying the Colorado group rocks, consists of a 100-foot-thick sandstone unit (Virgelle Sandstone) at the bottom. Above that are alternating layers of shale and fine-grained sandstone. Still higher in the sequence is fine-grained silty sandstone. The total thickness of Montana group is between 650 and 700 feet (CDM, 1981, p. 2.7-14). A thin coal seam also exists near the base of the undifferentiated Montana group rocks. The high percentage of shale rocks in the Colorado and Montana group rocks severely restricts ground water movement through them. (See Hydrology, Ground Water.)

Geologic Hazards

Most of the land under the Hertzler site is mantled with glacial outwash deposits. For the most part, this glacial material is stable, although there are some areas that have the potential to be unstable. The Bush Mountain area is probably capable of landslide or rockfall, as are very small acreages around Dead Horse Lake. The unconsolidated deposits in these areas are resting at steep angles. These potentially unstable slopes pose little hazard to cattle grazing, the existing land use.

The Hertzler Valley site is roughly 7 miles northeast of the minesite and is that much farther from known areas of frequent earthquake activity. The potential for severe earthquake ground shaking is therefore less than that of the minesite. The overall geologic hazard potential for the Hertzler Valley site is low.

HYDROLOGY

Surface Water

Stillwater River

Several surface water monitoring stations were established by Anaconda Minerals Company in June 1980. Some have been continuously maintained since then by Stillwater Mining Company. Flow and water quality measurements were collected on Verdigris Creek, Mountain View Creek, Nye Creek, West Fork Stillwater River, and on five sites along the Stillwater River.

III-12 / Hydrology

The Stillwater River flows within one-quarter mile of the mine and Stratton Ranch sites, generally less than a mile from FAS 419, and within three-quarters of a mile of the Hertzler Valley tailing site (fig. I-1). All water that flows from the project area drains into the Stillwater River. Most other drainages within the southeastern portion of the Beartooth Mountains also flow into the Stillwater River.

Flows in the river usually peak during June or July from snowmelt and increased spring precipitation. Roughly three fourths of the annual runoff occurs in May, June, and July (Camp Dresser and McKee, [CDM] 1981, p. 2.2-4). Near Woodbine Campground (about 3 miles upstream of the minesite), the maximum peak flow recorded during the period of June 1980 to June 1981 was 2,180 cubic feet per second; the lowest flow recorded was 35 cubic feet per second (January 1981), or 5 percent of the maximum flow. (The drainage area of the Stillwater River above this point is about 160 square miles.) The upper Stillwater basin has a high average annual precipitation rate (20 to 40 inches per year) and rough topography (maximum relief is 6,400 feet), which account for the wide range in water flows and high spring runoff.

The 100-year and 500-year flood-prone areas for the Stillwater River Valley north of the Custer National Forest boundary were outlined by the Soil Conservation Service in 1979 (CDM, 1981, p. 2.7-36). CDM (Anaconda's hydrology baseline study consultant) outlined the potential floodplain of the Stillwater south of the Custer National Forest boundary using physical evidence of past flooding. Based upon these two studies, SMC's proposed tailing impoundment and the Stratton Ranch tailing site are totally outside the estimated 500-year floodplain of the Stillwater River.

Surface water quality within the Stillwater River Basin is generally good to excellent, reflecting the undeveloped state of the area (Mid-Yellowstone Areawide Planning Organization, 1978) and the general lack of geologic strata that are capable of creating poor water quality. The Stillwater River is classified as a B-1 type by the Montana Department of Health and Environmental Sciences, meaning the water is generally suitable after conventional water treatment for drinking, cooking, and food processing. The water may be used without further treatment for bathing; swimming; recreation; growth and propagation of trout fisheries and associated aquatic life, water fowl and furbearers; and agricultural and industrial supply.

Total dissolved solids (a rough measure of salinity) is typically very low, usually below 100 milligrams per liter (mg/l). Dissolved solids, alkalinity, and hardness increase gradually downstream within the Stillwater River, which is a typical occurrence in streams of the region. The water is generally soft, is low in dissolved solids (11-152 milligrams/liter), is between 6.3 to 9.9 in pH (7 pH is neutral), and has a calcium bicarbonate composition. The river has a low buffering capacity because its water has fairly low alkalinity (1980-81 one-year average for the upper Stillwater River was 60 mg/l). A large amount of acidic water, if introduced, would affect the pH of the river. The river also exhibits low hardness (one-year average of upper Stillwater River was 34 mg/l). Water low in hardness tends to increase the toxicity of metals to aquatic organisms (McKee and Wolf, 1974), although no detrimental adverse effects on aquatic life have been documented in the Stillwater River as a result of metals. (See Aquatic Ecology.)

Although water quality is excellent in most stretches of the Stillwater River, a number of locations have natural concentrations of cadmium, lead, and manganese that occasionally exceed drinking water standards set by the U.S. Environmental Protection Agency (ARM 16.20.6) and the Montana Department of Health and Environmental Sciences (1980). The standards, 0.01 mg/l for cadmium, 0.05 mg/l for lead, and 0.05 for manganese, were established for water sources used by humans on a continuous basis.

Iron levels in the Stillwater River and some of its tributaries occasionally are also above the criteria established by the EPA for domestic water supplies (American Fisheries Society, 1979, p. 121). Iron levels above the criteria level of 0.3 mg/l are not necessarily harmful--humans have a very high tolerance for iron. Rather, the levels were established for aesthetic purposes (taste and staining of laundry).

The slightly elevated levels of iron, lead, and manganese (total rather than dissolved) occur during periods of peak flow, when sediment transport is highest (Stillwater Mining Company, 1984a, p. 2.2-19). Most of the metals are probably attached to the sediment. Filtration of the water would remove most of these metals attached to the sediment. Likewise, the metal-laden sediment would drop out of suspension if the water were allowed to stand motionless. Because these metals are attached to sediment, their impact to human uses and the aquatic community of the river are negligible.

Cadmium levels, by contrast, are highest during low-flow periods, indicating a majority of the cadmium is dissolved, rather than suspended in the water. Standard filtration processing of the water probably would not remove much of the cadmium. As a precaution, humans should not drink water from the river during low-flow periods. The elevated cadmium levels in stretches of the river may adversely affect sensitive species of aquatic life during low-flow periods.

Although the source of the elevated iron, lead, manganese, and cadmium levels has not been determined, they probably result from weathering of bed-rock in the upper Stillwater River Basin. For example, Verdigris Creek and the West Fork of the Stillwater River drain portions of the Stillwater Complex that contain sulfide and metal values above those normally found in the basin (CDM, 1981, p. 2.2-113). Accordingly, high average metal concentrations were found to be associated with channel sediments downstream of the confluence of these creeks and the Stillwater River.

Despite moderate increases in alluvial ground water nitrate and total nitrogen concentrations near the mine--a result of mine water seepage out of the existing percolation ponds (see chapter I)--concentrations in the river have largely been unaffected. Sampling stations both above and below the mine both had average nitrate concentrations of 0.09 mg/l for the five years the mine has been in development. The reason ground water quality has changed while the surface water quality has not lies in the fact that flow in the river is so much larger than either the percolation pond seepage or flow in the mine area ground water. The smallest amount of dilution of pond seepage by the time it reaches the river is 30 to 1 and normally is much greater.

III-14 / Hydrology

Even under the most severe conditions--high flow and high nitrate concentrations in the pond seepage and low flow and high nitrate concentration in the river--excessive algal growth in the river would not occur. Based upon the ratio of total nitrogen to phosphorus in the river (greater than 10 to 1, Hydrometrics, 1984) growth of algae in the river is limited by the availability of phosphorus. Additional nitrogen compounds would have no influence.

Phosphorus in the mine discharge water is higher than in surrounding ground water, but is quickly bound in soil particles before reaching offsite waters. Monitoring wells in the alluvial ground water next to the percolation ponds show no increase in phosphorus. As such, the mine has had no influence on algae growth or the quality of Stillwater River aquatic life.

All other dissolved constituents in the mine water, such as metals, have remained well below levels which would be considered to be significant. Again, the dilution by the river of the small amount of mine water would obscure any small peak in mine water concentrations.

Tributaries to the Stillwater River

The tributary streams of the Stillwater River have variable water quality. The alpine and subalpine creeks of the upper half of the Stillwater River basin generally have low dissolved solid values and creeks of the lower half generally have higher dissolved solids. Water quality within the tributaries is generally poorest during low flow.

Water quality and quantity measurements were obtained for Verdigris Creek, Nye Creek, Mountain View Creek, and the West Fork of the Stillwater River (fig. III-2). Verdigris, Mountain View, and Nye creeks are alpine-subalpine tributaries to the Stillwater River and flow only during part of the year.

Verdigris Creek runoff water contains high levels of sulfate. This stems from the weathering of small pockets of sulfide minerals (pyrrhotite, pentlandite and chalcopyrite) in the bedrock of the middle portion of the Stillwater Complex across which this creek flows. These pockets produce sulfate complexes and slightly acidic water upon weathering. In Verdigris Creek, the sulfates become especially concentrated during low flow (late summer and winter). Cadmium and iron levels also occasionally exceed criteria for drinking or domestic water supplies. The diversity of aquatic invertebrates within Verdigris Creek was less than other nearby creeks, indicating that metals within the water probably adversely affect aquatic life. (See Aquatic Ecology.)

Verdigris Creek cuts across a large ancient landslide, and during high spring runoff the stream water picks up tremendous amounts of sediment. The channel is constantly cutting into the landslide material, causing large blocks of material to fall into the creek (Jim Harrower, Anaconda Minerals Company, pers. com., April 22, 1982). For its size, this creek contributes a large proportion of suspended and bedload sediment, including total metal load, to the Stillwater River.

Nye Creek, on the southeast side of the Stillwater River Valley, directly across from the proposed mine, drains an area of about 4 square miles. Chromium, iron, and manganese levels have been measured at concentrations well above those suggested by the EPA (1980) for drinking and domestic water supplies (0.05 mg/l for chromium, 0.30 mg/l for iron, and 0.05 mg/l for manganese). The diversity of aquatic invertebrates within Nye Creek is also low and may indicate adverse effects of metals on the aquatic community. (See Aquatic Ecology.) The Stillwater Complex, as it cuts across the Stillwater Valley, occupies a large percentage of the Nye Basin. This probably accounts for the elevated sulfates and metals in Nye Creek. Nye Creek also cuts through an area where old tailings from the chromite mines was deposited (on the terraces of the Stillwater River). Wind-blown tailings are a major source of suspended sediment in the creek (Phil Jaquith, Custer National Forest, District Ranger, oral com., April 15, 1982).

Mountain View Creek flows along the southern boundary of the SMC's proposed tailing impoundment. It originates from Mountain View Lake and flows almost due east toward the Stillwater River. The topography between the lake and the river is steep. The creek has relatively low peak flows, owing to its small drainage area.

Water within Mountain View Creek was sampled for water quality on two occasions. The water was good enough to be used for drinking, but chromium levels may be high enough to slightly reduce productivity of sensitive species of aquatic life (CDM, 1980).

Anaconda Minerals Company tapped the overflows from Mountain View Lake in 1980 to supply water to the upper support adit for drilling. Roughly 25 gallons per minute of water were drawn out from the lake for periods of about 6 hours a day (Hydrometrics, 1981). This withdrawal has had no discernible effects on the lake or the creek.

In places, the West Fork of the Stillwater River has cadmium and iron levels slightly above EPA criteria for drinking and domestic water supplies. The same Stillwater complex rocks containing pyrite underlie portions of the West Fork Basin and probably cause the reduced water quality. Overall, the presence of aquatic invertebrates that are sensitive to environmental degradation indicates that the West Fork of the Stillwater River generally has good quality water.

Minesite (Proposal and Alternative 1)

Most of the minesite is drained by very small ephemeral drainages that flow directly into the Stillwater River. No attempt was made to sample water from these drainages. Mountain View Creek flows along the southern edge of the proposed tailing impoundment (see Tributary discussion above).

Stillwater Mining Company's underground workings have produced between 30 and 350 gallons per minute of water. During active mining, the Minneapolis Adit has produced an average of about 150 gallons per minute, peaking at 350 gpm. During mine shutdown from early 1982 to October 1983, the mine discharge

dropped gradually to about 30 to 40 gpm. This water is temporarily retained in a series of percolation ponds before it enters the ground water system of the Stillwater River. (See Ground Water.) To date, no surface water discharge from these ponds has occurred. The percolation ponds are sufficiently large that no surface water discharge is expected. (See chapter II.)

To date, the quality of water coming out of the Minneapolis adit has been good. No adverse impacts on the surface waters of the area have occurred from Anaconda's or Stillwater Mining Company's exploration activities. Even so, mining has increased ammonia, nitrate, and phosphorus concentrations of the mine adit discharge. Nitrate and ammonia concentrations during active mining have averaged more than ten times higher than undisturbed bedrock ground water concentrations. (See Ground Water, table III-1.) Phosphorus concentrations are roughly three times nonmining concentrations. Incomplete combustion of ammonia nitrate fuel oil explosives is the major cause of these increases in mine adit discharge water during active mining. The mine water is sent to percolation ponds, where it becomes part of the alluvial ground water system.

Stratton Ranch Site (Alternatives 2 and 3)

The Stratton Ranch site is located primarily on the uppermost terrace of the Stillwater River, well above the 500-year flood plain. A small perennial creek flows due east off the uplands above the site and disappears into alluvial fan deposits before reaching the actual impoundment site. The alluvial fan material exists where the steep perennial stream channel meets the relatively flat terrace of the Stillwater River. The coarser-grained alluvium was deposited in this fan, allowing the creek to seep into the ground water system.

The creek does flow all year round above the alluvial fan and potential tailing pond site, but flow records are unavailable. Water quality data are also unavailable for this creek.

Several perennial ponds exist near the site. Four are within one half mile of the site. Three of the ponds are located in the hummocky terrain of an old landslide flanking the site on the northwest. Another pond exists in the middle of the potential tailing impoundment. It is a manmade (bermed) pond with water levels maintained by inflow from the perennial creek. No water quality data are available on these ponds, although they all are believed to be of good quality; fish and other aquatic life were observed in the pond located within the impoundment site, indicating relatively good quality water.

Hertzler Valley Site (Alternatives 4, 5, and 6)

Two small, poorly developed coulees with no distinct drainage channels drain the Hertzler site. Both drainages start at the base of Bush Mountain and end in Hertzler Valley. The two drainages rarely, if ever, carry runoff. Rainfall and snowmelt falling on the site infiltrate into the glacial material, to be consumed by vegetation or become part of the ground water system.

No surface runoff occurred in the two small drainages occupying the Hertzler Valley site during a one-year sampling period (July 1980 to July 1981). As such, water quality analyses are not available.

Castle Creek flows down the center of the Hertzler Valley and has a small, indistinct drainage channel. An irrigation ditch that brings water from the West Fork of the Stillwater River does fill the channel (near the Hertzler homestead) during the irrigation season, but the Castle Creek channel is normally dry.

Runoff flowing into the Hertzler Valley from the north (Robinson Draw, Stanley Coulee, and Tandy Coal Mine Draw) appears to flow into the irrigation ditch, rather than reaching the Castle Creek channel. All three drainages are ephemeral, meaning they flow only in response to rapid snowmelt or intense rainstorm events. Runoff within these drainages occasionally contains constituent levels--cadmium and iron most often--above standards set for drinking water. Fecal coliform and sulfate values were also found to occasionally exceed recommended drinking water criteria (Environmental Protection Agency, 1981, and Montana Department of Health and Environmental Sciences, 1980). The bedrock (Eagle Formation) underneath these drainages contains sulfide metal complexes that slightly acidify runoff waters and probably are the reason for the elevated cadmium and iron values. Even though these waters are unsuitable for human consumption, they are of good enough quality for irrigating and stockwatering, their primary use.

Ground Water

Minesite (Proposal and Alternative 1)

At the minesite two distinct groups of geologic units contain ground water: bedrock units and unconsolidated surficial deposits.

Bedrock Aquifer. Bedrock lies on both sides of the Stillwater River and beneath the surficial deposits that occupy the valley (fig. III-3). Ground water in the bedrock is mainly confined to openings such as joints, faults, and shear zones. The amount of ground water that could be extracted is difficult to predict and is highly variable (Stillwater Mining Company, 1984a, p. 2.4-7). The natural variability in geologic and hydrologic conditions makes it impossible to accurately predict ground water flow. (Stillwater Mining Company, 1984a, p. 2.4-17). For this reason bedrock in the upper Stillwater Valley Basin would not be a good unit to drill into for the sole purpose of obtaining water.

Large influxes of ground water into the main adit were not encountered during underground excavation, with the exception of one area. In that area, significant flows (170 gpm) were found in faults and shears that paralleled the banding of the Stillwater Complex rocks. Flows estimated at the working face of the adit ranged from less than 1 gallon per minute (gpm) to over 100 gpm. The total discharge of the adit peaked in June of 1980 at 385 gpm, but has decreased to as low as 30 gpm. All flows from fractures and drill holes have typically decreased with time to low, constant discharge rates.

Recharge of the bedrock ground water system probably occurs mostly at higher elevations, where snowmelt and rain infiltrate and percolate along joints, fractures, and bedrock discontinuities. Some recharge to the bedrock may occur via infiltration of ground water from saturated alluvial or other unconsolidated deposits located along the flanks of the Stillwater River.

Ground water leaves the bedrock as (1) surface springs and (2) discharge to unconsolidated subsurface materials low in the valleys and draws of the region. Fourteen springs have been identified between the mine and Hertzler Valley. Nine of these have been developed for domestic or livestock water supply (CDM, p. 2.3-23).

Ground water discharge from bedrock most likely contributes significantly to alluvial ground water and possibly surface water systems of the Stillwater River. Bedrock discharge, along with infiltrated surface runoff from snowmelt, contributes to the perennial character of the Stillwater River (Stillwater Mining Company, 1984a, p. 2.4-9).

Stillwater Mining Company's exploration adit has modified the flow pattern of ground water immediately around the excavations. Prior to the exploration work, ground water intercepted by the underground working flowed toward the Stillwater River Valley. Now it flows into the underground excavations and is directed to percolation ponds, where it seeps into the alluvium of the Stillwater River.

The dewatering of bedrock around the Minneapolis adit may have reduced the flow of a spring that was used as the sole water supply to the Hjelvik residence located 500 feet downslope of the Minneapolis adit. Anaconda replaced the depleted Hjelvik spring with a Stillwater River alluvium well. Adverse effects of continued development on other springs in the area have not been documented.

Ground water is generally of drinking-water quality in the bedrock immediately surrounding the platinum-group mineralized zone. Sulfide and metal values are low in this zone, leading to the relatively good quality of water. (See Geology.) In contrast, bedrock within the Stillwater Complex farther away from the platinum-group metals contains considerably higher amounts of sulfides; therefore, ground water passing through these areas is expected to have higher metal values than most of the ground water in the upper Stillwater River basin. Indirect evidence of poorer quality water in bedrock surrounding the platinum zone comes from three wells (fig. III-4) drilled in the Stillwater River alluvium immediately downgradient of the existing percolation ponds. Bedrock containing relatively high amounts of pyrite probably contributes to the poor quality of water in Verdigris and Nye creeks and the West Fork of the Stillwater River.

Unconsolidated Deposit Aquifers of the Minesite. The alluvium along the Stillwater River is the major source of ground water in the valley. (See figure S-1 for conceptual view of the valley alluvium.) The general flow direction for the Stillwater River alluvial ground water is downstream, or from the south and west to the north and east. The Stillwater alluvium is

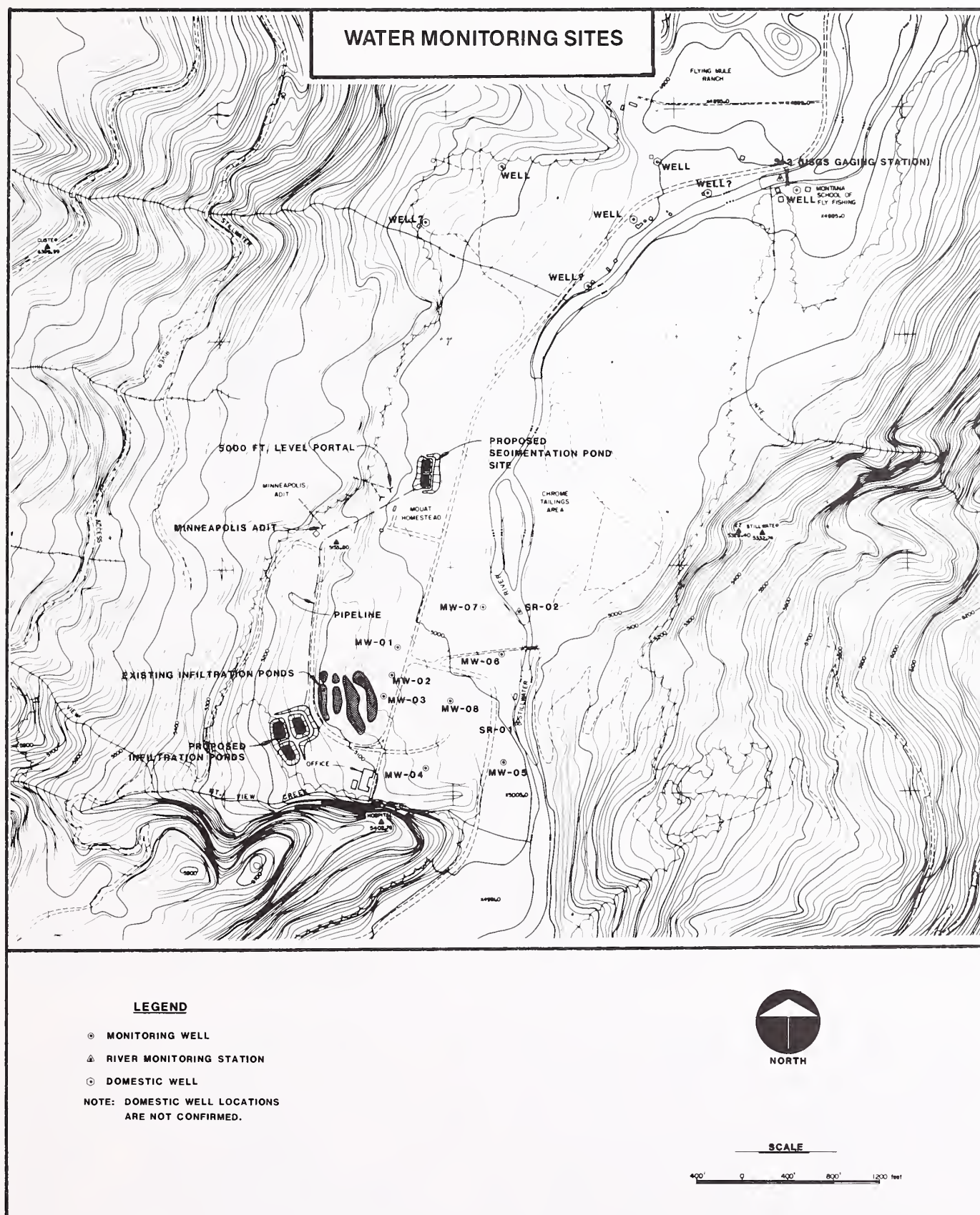


FIGURE III-4

Stillwater Mining Company drilled a number of wells within and below the project site to characterize ground water quality. The company also took monthly surface water samples at several stations along the Stillwater River. (See fig. III-8.)

capable of producing more than several hundred gallons a minute without a noticeable reduction. At least 17 wells are known to produce water from the alluvial deposits in the upper Stillwater River Valley. Fifteen of these are used as domestic water supplies.

Other surficial deposits of mass-wasting and glacial origin are present throughout the project area. These consist of talus, landslide deposits, glacial deposits, and other forms of loose, heterogeneous and unconsolidated material deposited chiefly by mass wasting.

The landslide deposits are variably saturated because of their jumbled physical and textural properties. Numerous springs found in the Beartooth Mountains are associated with landslide deposits. Several springs issue from the large landslide located just north of the Minneapolis adit (fig. III-3). Within the Stillwater River Valley, one spring associated with a landslide has been developed for domestic use and several others are used by livestock and wildlife.

Ground-water wells in the unconsolidated deposits of the Stillwater Valley upstream of the minesite are located at the Beartooth Ranch and the Woodbine Campground. The ground water in these wells is of very good quality with measured values well below the limits set for drinking water. The Stillwater River Valley alluvial deposits generally have very good quality water, although localized areas within the alluvium, such as the minesite and old chromite tailing disposal site, do have metal concentrations that exceed drinking water standards. The location of all such areas are not known.

In late 1979 Anaconda drilled three observation wells (MW01, MW02, and MW03) immediately downgradient of the percolation ponds used to treat the Minneapolis adit discharge water. All three were completed in Stillwater River alluvium. In the fall of 1983, Stillwater Mining Company drilled five additional alluvial monitoring and exploration wells (MW04, MW05, MW06, MW07, and MW08) in the proposed tailing impoundment site (fig. III-4). All eight wells were used to characterize the alluvial aquifer geometry, hydraulic properties, flow conditions and ground water quality of the tailing impoundment site. The wells indicate the alluvial aquifer varies from approximately 50 to 250 feet thick and averages about 100 feet under the minesite. In general, ground water flow in the alluvium near the mine is primarily to the north, approximately parallel to the river. Ground water flow immediately under the minesite is modified by the rather deep bedrock basin. Ground water enters the basin from the southeast around a bedrock ridge, spreads out under the impoundment site, then exits the basin to the northeast. Ground water nearer the river follows the northerly flow of the Stillwater River. Recharge to the alluvial aquifer principally comes from the Stillwater River, although some ground water enters the alluvial ground water from the bedrock. During low river flow, alluvial ground water appears to discharge to the Stillwater River along the northeastern margins of the minesite basin.

The amount of ground water passing through the alluvium immediately under the tailing impoundment site is difficult to accurately predict. The alluvium-filled basin has a complex shape and the saturated thickness and hydraulic conductivity values of the alluvial material vary. The alluvial flow rate could range from as little as 1,000 gpm to as high as 2,000 gpm, with the most probably flow rates being about 1,500 gpm.

Coarse-grained alluvial gravel (hydraulic conductivity of 200-400 feet/day) at depth account for the rather high flow rate through the Stillwater River valley deposits. Relatively low-permeability alluvial material (hydraulic conductivity of 5 feet/day) overlies the coarse-grained deposits, creating a semi-confined (artesian) alluvial aquifer at depth. Depth to ground water under the minesite ranges from 40 to 90 feet.

The monitoring wells indicate that the alluvial ground water quality is better close to the river. Ground water samples from the three wells closest to the river were below drinking water standard values, but water in the three wells (MW01, MW02, and MW03) near the percolation ponds exceeded drinking water criteria for one or more of the following constituents: total dissolved solids (TDS), chromium, iron, and selenium. Natural seepage of ground water through mineralized bedrock is believed to be the major source of elevated metal values. Seepage out of the Minneapolis adit percolation pond may also contribute slightly to the elevated levels in the three wells. (Evaporation of pond water could increase dissolved metal concentrations in the ground water.)

None of the wells located closer to the river contains water exceeding drinking water standards. These wells are considered to be representative of premining conditions.

The three monitoring wells closest to the percolation ponds also had higher ammonia and nitrate concentrations than monitoring wells closer to the river (table III-1). Ammonia concentrations in wells nearest the ponds, though low, are two to three times background levels. Ammonia concentrations are much higher in the adit water than in ground water, but much of the ammonia is converted in the ponds to nitrate by bacteria before reaching the ground water. As such, the ammonia in the mine water indirectly adds to the nitrate loading of the ground water.

The mine discharge water also contains fairly high amounts of nitrates, which add to the nutrient loading of the underlying ground water. Nitrate concentrations are as much as 10 times greater in the ground water near the percolation ponds (MW01, MW02, and MW03) than in ground water adjacent to the streams (MW04, MW07, and MW08). (See table III-1.)

Dilution of pond seepage water in the alluvial ground water downstream of the mine is believed to render all but nitrates undetectable from baseline conditions. Nitrate concentrations in monitoring wells closest to the ponds have remained below 3 mg/l, averaging about 1 mg/l, well below the drinking water standard of 10 mg/l. Alluvial ground water farther downstream probably contains less than 3.0 mg/l of nitrates due to mixing of the pond's nitrate plume in the alluvial ground water. For comparison, background nitrate concentrations have averaged about 0.1 mg/l (wells MW06, MW07, and MW08). The elevated nitrate concentration would not preclude the use of the ground water for drinking water or other purposes.

During low flow some of the alluvial ground water containing the percolation pond water entered the Stillwater River. However, dilution in the river appears to have masked any changes due to the mine; the river water would generally dilute pond seepage by a factor of over 100 to 1. Nitrate and ammonia concentrations have remained low both above and below the mine.

TABLE III-1

Ammonia, Nitrate, and Phosphorus Concentrations in Ground Water

	During Active Mining (1980-1981)		Shutdown (1982-Oct. 1983)	
	Mean	Range	Mean	Range
<u>Minneapolis Adit Discharge</u>				
Ammonia (NH ₄ -N)	0.76	0.02-3.57	0.11	0.02-3.57
Nitrate (NO ₃ -N)	1.7	0.11-5.23	0.07	0.02-0.18
Phosphorus (Total)	0.06	0.01-0.53	0.02	0.01-0.5
MW01 (Well)				
Ammonia (NH ₄ -N)	0.06	<0.01-0.16	0.09	0.01-0.20
Nitrate (NO ₃ -N)	0.49	0.01-0.73	0.56*	0.01-0.92
Phosphorus (Total)	0.04	<0.01-0.08	0.02	0.01-0.08
MW02 (Well)				
Ammonia (NH ₄ -N)	0.12	0.01-0.26	0.09	0.01-0.20
Nitrate (NO ₃ -N)	2.09	1.40-2.84	2.40*	1.47-2.24
Phosphorus (Total)	0.05	0.01-0.48	0.02	0.01-0.05
MW03 (Well)				
Ammonia (NH ₄ -N)	0.07	0.01-0.19	0.09,	0.11-0.26
Nitrate (NO ₃ -N)	0.38	0.29-0.54	0.32*	0.16-0.40
Phosphorus (Total)	0.04	0.01-0.15	0.02	0.01-0.04
MW06 (Well)				
Ammonia (NH ₄ -N)			0.03	0.01-0.12
Nitrate (NO ₃ -N)			0.17*	0.07-0.28
Phosphorus (Total)			0.03	0.01-0.05
MW07 (Well)				
Ammonia (NH ₄ -N)			0.03	0.01-0.13
Nitrate (NO ₃ -N)			0.06	0.02-0.12
Phosphorus (Total)			0.01	0.01-0.05
MW08 (Well)				
Ammonia (NH ₄ -N)			0.03	0.01-0.12
Nitrate (NO ₃ -N)			0.07	0.01-0.30
Phosphorus (Total)			0.01	0.01-0.05

*Monitoring wells were still influenced by percolation pond water despite temporary mine shutdown.

Total phosphorus concentrations are also elevated in the adit discharge water but approach background concentrations before reaching nearby monitoring wells. Phosphorus is evidently bound to sediment trapped in the percolation ponds.

Three additional observation wells were installed across the river from the mine. The wells were completed in the alluvial deposits upon which chromite mill tailings were deposited in the 1950s. Water samples collected from the alluvium beneath the tailings exceeded the drinking water limits for iron, lead, manganese, cadmium, and chromium. The old chromite tailings may contribute metals to the alluvial ground water system, as might the natural seepage of mineralized bedrock ground water. (Nye Basin, located upgradient and to the east of this tailings area, contains some Stillwater Complex rocks with high concentrations of sulfides and metals.) The relative contributions from tailings and from natural bedrock were not determined.

Stratton Ranch (Alternatives 2 & 3)

The Stratton Ranch site is similar to the minesite in many respects. The site is located on a wide terrace of the Stillwater River that is confined by a prominent bedrock ridge on the south and by unconsolidated moderately-sloped deposits on the east. A large percentage of the ground water flowing under the impoundment site is believed to enter the basin from the southeast around the bedrock ridge. Surface water from the perennial creek, which enters the site from the uplands to the west, infiltrates into underlying alluvium, adding several hundred gallons per minute to the ground water system. Ground water leaves the site to the north-northeast, parallel to the flow of the Stillwater River.

Ground water levels are shallow at this site. One well completed in the alluvium along the approximate centerline of the potential impoundment dam encountered ground water at 20 feet. Ground water is even shallower in the landslide deposit forming the western margins of the impoundment area. Both wells completed in this landslide material encountered water at depths of less than ten feet.

No water quality information is available for the immediate impoundment area, but based upon nearby alluvial wells, the site's ground water quality is probably good.

Hertzler Valley Site (Alternatives 4, 5, and 6)

Ground water in the Hertzler Valley is primarily found in two distinct geologic units: sedimentary bedrock and unconsolidated surficial deposits. The majority of the Hertzler Valley is underlain by sedimentary shale and sandstone. (See Geology, Bedrock). The bedrock is mantled with up to several hundred feet of unconsolidated glacial and alluvial deposits.

Sedimentary Bedrock. Ground water is available in the sedimentary units, but generally is not used where more reliable near-surface water in unconsolidated deposits exists. Overlying unconsolidated surficial deposits generally can produce greater quantities of ground water and at more predictable depths than the bedrock strata.

Ground water in the sedimentary rocks of the Hertzler Valley generally flows toward the valley bottom, roughly following the relief of the landscape. Much of the lower elevations are underlain by bedrock composed of shale (Colorado Group). The Colorado Shale is roughly 1,000 times less permeable than the overlying sand and gravel. The shale does not allow easy passage of ground water, severely limiting the amount of vertical leakage from the overlying surficial deposits. Alluvial wells, when pumped, dropped water levels slightly in observation wells completed in the shale, which indicates that the upper portion of the shale bedrock is to a small degree hydrologically connected with the overlying saturated unconsolidated material and that some exchange of ground water between the two units is possible.

Unconsolidated Surficial Deposits. The depth of unconsolidated material within the Hertzler Valley varies. The thickest accumulation occurs along the central east-west axis of the valley. The material is composed primarily of a mixtures of alluvial fan and glacial outwash deposits. Most of the ground water in the alluvium moves through the basal coarse-grained deposits (primarily cleaned glacial outwash) in an unconfined (nonartesian) state.

During most of the year, these unconsolidated deposits are saturated with ground water at depths ranging from 90 feet at the western end of the valley to 40 feet at the eastern end, where the Hertzler Valley joins the Stillwater River. Water levels vary with the season: The watertable is highest during the late spring and summer, lowest during winter and early spring. It rises as much as 20 feet from low to high periods.

Ground water always moves from higher to lower ground water table elevations. In the Hertzler Valley, ground water moves down the axis of the valley, from west to east, eventually reaching the Stillwater River Valley. Because the bedrock underlying the valley is of low permeability, the vertical loss of alluvial ground water to the underlying bedrock is minimal.

Ground water can be extracted from the unconsolidated deposits of the Hertzler Valley at high rates. Several observation wells drilled by Anaconda were capable of producing more than 200 gallons per minute (gpm), sufficient for sprinkler irrigation of hay fields.

Infiltration of irrigation waters is a major source of recharge for the valley ground water system: Over half (600 gpm) of the irrigation water brought in from the West Fork of the Stillwater River is lost to infiltration (Anaconda Minerals Company, written com., October 1981). The irrigation ditch runs most of the length of the Hertzler Valley and is used to flood-irrigate hayfields.

Water Quality. The quality of ground water in the unconsolidated deposits of the Hertzler Valley is poor to excellent, depending on what the water is used for. All six observation wells drilled by Anaconda in the unconsolidated deposits tapped ground water of quality suitable for use in irrigation or stock watering, the water's primary use today. Valley ground water was found to be consistently above the recommended drinking water limit for iron. Three of six observation wells also had lead values above the recommended limit for drinking water (4 to 15 times the drinking water standard). Manganese was above the drinking water limit of 0.05 mg/l for four of six wells in the valley. (See table in Chapter IV, Hydrology, Ground Water, wells H1A, H3, H4, H5, H6, and H8.) In general, alluvial ground water under most of the Hertzler Valley would not be desirable for domestic water supplies. The origin of the constituents that make the water undesirable for drinking water is unknown, but probably is the poor quality water seeping upward from the underlying bedrock and from infiltration of surface water.

Water quality samples taken from two observation wells (H2 and H7) completed in the bedrock that underlies most of the valley (Colorado Shale Group) exceeded the drinking water limits for the following constituents: total dissolved solids, arsenic, cadmium, chromium, iron, lead, manganese, selenium, silver, and sulfate. The poor quality of the water in the Colorado Group rocks, coupled with the very small amount of ground water that could be pumped from the units, makes the Colorado Shale an undesirable ground water source.

The only reported domestic well (R.L. Curtin) in the Hertzler Valley is located within a small unnamed tributary along the north central part of the valley. The water quality of this well, which is not in the main drainageway of the Hertzler Valley, meets drinking water standards.

SOILS

The soils within and near the Stillwater Project have been mapped at two levels of intensity. A detailed (Order I) soil survey was conducted on about 5,320 acres, including the 550-acre proposed permit area. The remainder of the 24,500-acre study area was mapped at a broader (Order III) level.

Overview

The soils in the area studied are variable. This variability stems from differences in climate, vegetation, parent material, topography and time of development (age). In this mountainous area, climate and vegetation are the two predominant factors affecting soil formation. The climate of the region, classified as "mountainous continental," is characterized by large daily and annual temperature ranges, as well as marked differences in precipitation and wind patterns over a distance of only a few miles. (See Climate.)

A noticeable vegetative and soil change takes place at an altitude slightly above 5,000 feet. Scattered ponderosa pine, Douglas fir, lodgepole pine, and limber pine generally predominate above this altitude; grass cover predominates below. This creates differences in the soil. As plants die and decompose, they contribute nutrients, litter, and organic matter to the soil. Soils that are formed under grassland at lower altitudes do not leach readily and the subsoils are often calcareous. The organic matter from the grasses is responsible for the characteristically thick, dark-colored, neutral to mildly alkaline surface (A_1) horizon of these soils.

Decomposing litter from a coniferous forest produces more organic acids than decomposing litter from grass. At an altitude above 6,000 feet precipitation increases, temperature decreases, and the soils become more acidic with a lower base exchange. Soils thus develop under conditions of acid hydrolysis. They are characterized by a relatively thin surface (A_1) horizon, a light ashy-colored eluvial (leached) horizon below the surface horizon, and a reddish-colored illuvial (accumulation) horizon below the eluvial horizon.

In the area studied, the materials from which the soil developed (soil parent materials) were derived from locally weathered bedrock or were transported from higher elevations of the Stillwater drainage. The transported material was moved by gravity, wind, glaciers, or water to its present location. Glaciation and water action have performed the dominant role in the evolution of valley topography. Glaciers have left stones--and streams have deposited alluvial gravels--that cap terraces and benches along the valley, as illustrated in figure III-5. This figure also shows representative soil series for various topographic and geologic locations.

The landscape of the project area exhibits a general soil-plant relationship. The nature of the soil and parent materials determines the kind and, to a considerable extent, the distribution of vegetation, since plant growth is heavily dependent on the chemical and physical characteristics of the soil. However, such factors as past land use practices, micro-relief, and micro-climate may have altered the expected soil-plant relationships in some parts of the valley.

Soils of the Proposed Permit Area (Including Alternative 1)

The soils of the proposed 550-acre permit area are shallow (less than 20 inches) to deep (40 or more inches), have a coarse to fine texture, are moderately acid to moderately alkaline, are low in soluble salts and sodium, and are low to moderate in water- and nutrient-holding capacity.

The natural soils that would be disturbed at the proposed mine, mill, and tailing areas are generally stony, cobbly, or gravelly and mostly coarse- to medium-textured. Much of the soils occupying the site of the proposed mill and tailing pond have been disturbed by previous mining activities. These soils are highly variable, and therefore cannot be specifically classified. Based on the submitted data, there are no chemical elements in these soils that would pose a hazard to plants, animals, or humans.

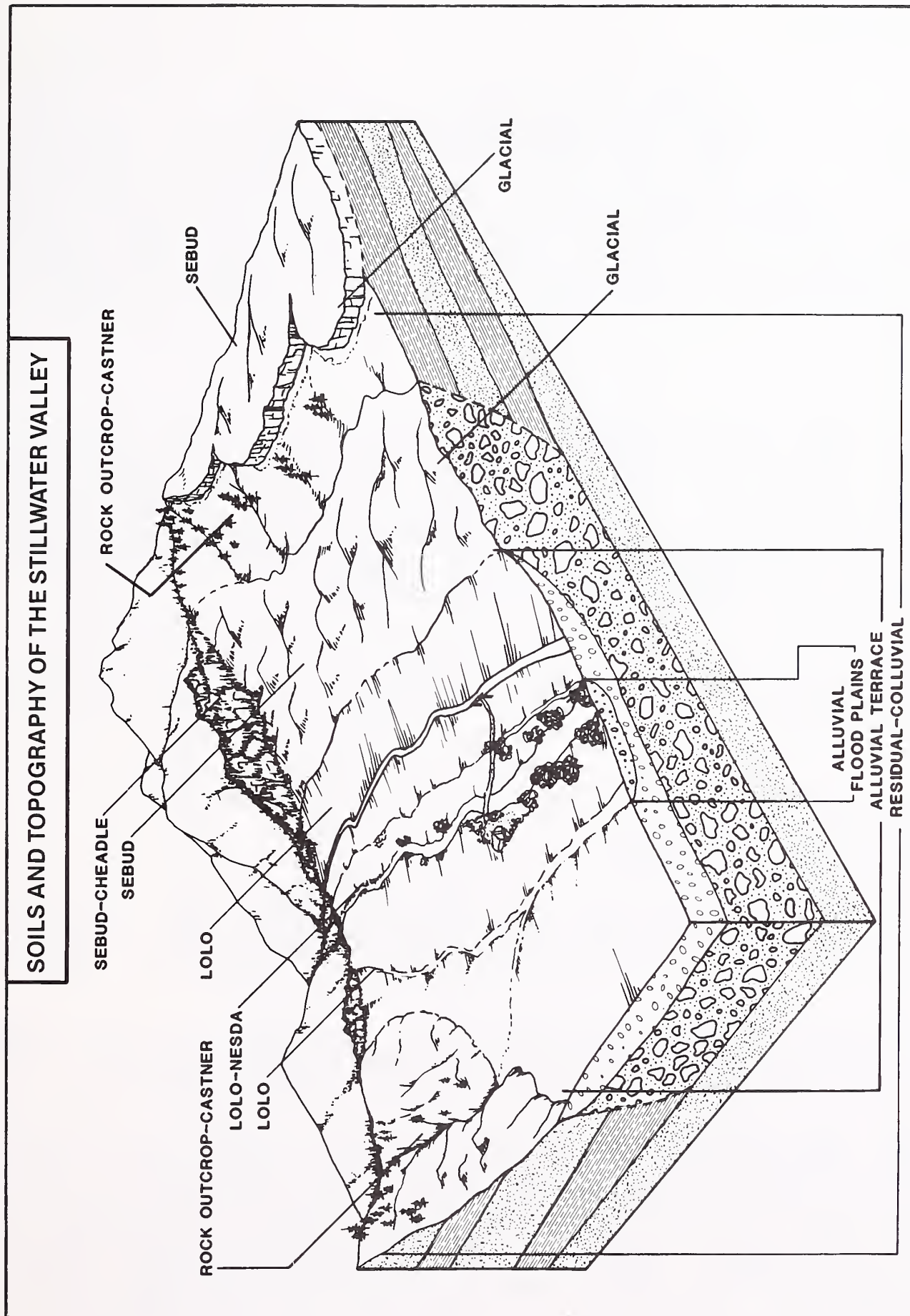


FIGURE III-5

Soils in the project area have developed mostly from weathered bedrock. Glaciers, wind, and water have deposited soils in their current location. The bottom of the valley is capped with stream-laid deposits. Upper slopes are capped with debris (colluvium) that has fallen or washed down from higher elevations.

III-28 / Soils

Stratton Site Soils (Alternatives 2 and 3)

Stratton site soils are deep, well-drained and medium-textured. Most of the soils here are either very stony, cobbly, or gravelly, or a combination thereof. In some areas, large boulders are present at the surface and in the soil. The soils are slightly acid to slightly alkaline, are low in soluble salts and sodium, and are low to moderate in water- and nutrient-holding capacity. No site-specific chemical data are available for this site; however, based on the site's geology, it is probable that no chemical elements are present in amounts that would pose a hazard to plants, animals, or humans.

Hertzler Site Soils (Alternatives 4, 5, and 6)

Hertzler site soils are similar to those at the Stratton site. Nearly all Hertzler site soils are deep, well-drained, medium-textured, and very stony. In some places, large boulders are present at the surface and in the soil. The soils are neutral to moderately alkaline, are low in soluble salts and sodium, and are low to moderate in water- and nutrient-holding capacity. Based on the submitted data, there are no chemical elements in these soils that would pose a hazard to plants, animals, or humans.

Prime Farmlands

No prime farmland soils exist in the proposed permit area or in any of the alternatives.

VEGETATION

Vegetation Type Descriptions

The Stillwater vegetation study area (fig. III-6) encompasses about 24,547 acres along the Stillwater River (Camp Dresser and McKee, 1981). Elevations rise from 4,690 feet along the river to 9,050 feet in the southeast portion of the area.

Thirteen vegetation types (tables III-2, III-3 and fig. III-7), along with water and disturbed areas with no vegetation, have been identified in the study area. (See Land Use for range condition and stocking rates.)

(1) Stony Grassland. This type occurs on level to rolling foothills and slopes at elevations ranging from 4,756 feet at the valley floor to about 5,248 feet. The type is dominated by perennial forbs and grasses; the remaining vegetation consists of nonflowering plants. Among the forbs, silvery lupine, blazing star, and Hood's phlox are the most abundant. (See appendix E for scientific names.) Idaho fescue is the most abundant grass; however, needle-and-thread, blue grama, little bluestem, western wheatgrass, and bluegrass are common. Additionally, rock salaginella, sun sedge, and lichens are common.

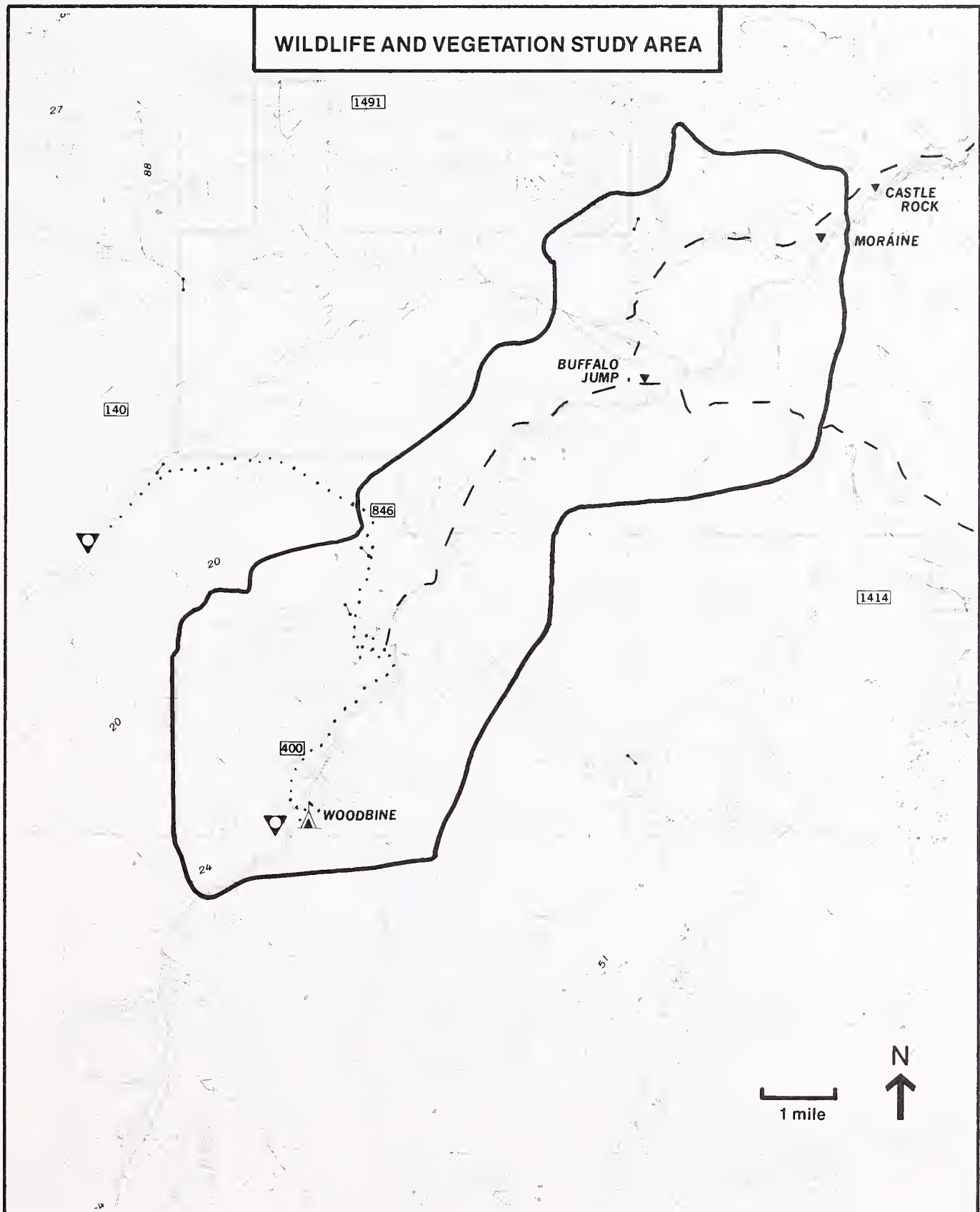


FIGURE III-6

For studies of vegetation and wildlife, Camp Dresser and McKee analyzed a ten-mile-long area that included the Stillwater River Valley and the uplands to either side. All lands considered in alternative tailing sites were included in the CDM study area.

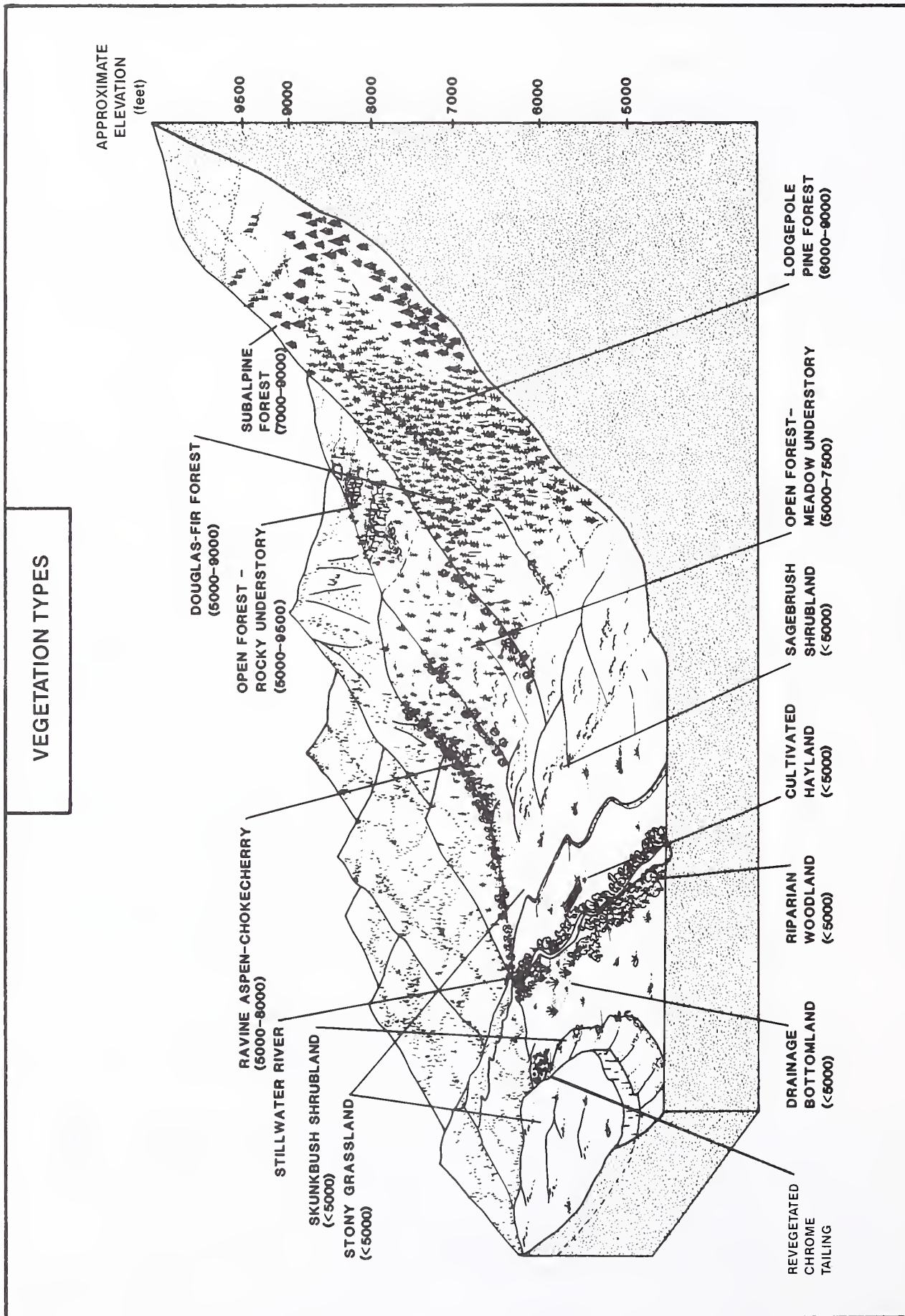


FIGURE III-7

The study area contains 13 vegetation types, including the chrome tailings that Anaconda Minerals Company revegetated in the 1950s. Part of the project site lies on lands that have already been disturbed by mining.

TABLE III-2
Vegetation Types in the Stillwater Study Area

Vegetation Type	Entire Study Area		Proposed Disturbance		Estimated Acres Disturbed by					
	Acres	Percent ²	Area ¹		Alternatives ¹					
			Acres	Percent ²	#1	#2	#3	#4	#5	#6
Stony grassland	6,158	25	4	2	0	68	46	165	175	131
Sagebrush shrubland	172	1	0	0	0	0	0	13	15	11
Skunkbush shrubland	995	4	0	0	0	9	6	0	0	0
Drainage bottomland	320	1	0	0	0	0	0	0	0	0
Riparian woodland	1,258	5	0	0	0	0	0	0	0	0
Ravine aspen-chokecherry	552	2	2	1	1	10	7	1	1	1
Open forest-meadow understory	3,022	12	53	32	37	59	44	16	16	16
Open forest-rocky understory	5,630	23	31	19	25	25	25	25	25	25
Douglas-fir forest	2,276	10	1	1	1	1	1	1	1	1
Lodgepole pine forest	1,832	8	6	4	4	4	4	4	4	4
Subalpine forest	427	2	5	3	2	2	2	2	2	2
Revegetated chrome tailings	75	- ⁴	0	0	0	0	0	0	0	0
Cultivated hayland	1,488	6	0	0	0	0	0	1	1	1
Disturbed lands ³	332	1	63	38	66	43	43	43	16	43
Water	10	- ⁴	0	0	0	0	0	0	0	0
TOTAL	24,547	100	165	100	136	221	178	271	256	235

Source: Camp Dresser and McKee, 1981.

¹ Does not include acres disturbed by slurry lines. Alternatives 2, 3, 4, and 6 include a 15-acre emergency tailing pond that, it is assumed, would be located on disturbed lands at the minesite.

² Percentages rounded to nearest whole number.

³ Disturbed areas include abandoned mine areas, roads, and current disturbances related to SMC's exploratory operations.

⁴ Less than 1 percent.

(2) Sagebrush Shrubland. This type is found on north- and east-facing slopes, where winds commonly deposit snow on the lee side of ridges and knolls. Sagebrush shrubland occurs at low elevations--below 4,920 feet on nearly level to relatively steep slopes.

Big sagebrush is the dominant species within this vegetation type. Grass and grasslike species that characterize this type include bluegrass, Japanese brome, needleleaf sedge, and sun sedge. Lupine is a commonly observed forb.

(3) Skunkbush Shrubland. This vegetation type is characterized by skunkbush sumac on south- and west-facing slopes. It is found on steep slopes, usually below 4,920 feet. Dominant grass species include bluebunch wheatgrass and needle-and-thread, along with minor amounts of blue grama, cheatgrass, and bluegrass. Common forbs are Hood's phlox, and slimflower scurfpea. Lichens are also a significant ground cover.

III-32 / Vegetation

TABLE III-3

Characteristics of Vegetation Types on the Stillwater Study Area

Vegetation Type	Range Site	Range Condition ¹	Perennial	Shrub ² Production ² (lbs/acre/ year)	Deciduous Tree ³ Density (no/acre)	Coniferous Tree ³ Density (no/acre)	Shrub ⁴ Density (no/acre)
			Grass Production ² (lbs/acre/ year)				
Stony Grassland	Stony	Good (50%)	380	64	0	0	2,231
Sagebrush Shrubland	Stony	Poor (24%)	308	855	0	20	8,478
Skunkbush Shrubland	Stony	Fair (28%)	211	211	0	0	6,455
Drainage Bottomland	Sub- irrigated	Fair (37%)	1,109	456	113	0	2,387
Riparian Woodland	Sub- irrigated	Good (56%)	222	409	1,944	38	37,124
Ravine Aspen - Chokecherry	Sub- irrigated	Good (71%)	83	309	1,945	673	23,877
Open Forest - Meadow Understory	Stony	Excellent (87%)	150	1,046	3	847	9,622
Open Forest - Rocky Understory	None	-	-	-	73	462	4,256
Douglas-fir Forest	None	-	-	-	40	4,948	5,828
Lodgepole Pine Forest	None	-	-	-	8	6,244	7,834
Subalpine Forest	None	-	-	-	0	4,743	8,823
Revegetated Chrome Tailings	None	-	394	0	0	0	0

Source: Camp Dresser and McKee, 1981.

¹Based on U.S. Soil Conservation Service (1981) methods which do not classify some forested and disturbed areas as rangeland.

²Production was not estimated for disturbed, rocky, or densely forested vegetation types.

³Woody species reaching 1 cm diameter at 130 cm were defined as trees. Densities were not estimated for cultivated hayland or disturbed areas with no vegetation.

⁴Fringed sagebrush not included.

(4) Drainage Bottomland. This is a wet-meadow type generally found in swales or low-lying areas and dominated by wetland grasses and forbs. The vegetation has been strongly influenced by grazing, irrigation, and other disturbances, often resulting in a weedy species composition. This type occurs on level terrain between 4,756 and 5,018 feet.

Dominant grasses include bluegrass, needle-and-thread, and meadow fescue. Sedge and rush species include beaked sedge, Tule bulrush, and spikesedge. Common dandelion, red clover, and field mint are the most abundant forbs.

(5) Riparian Woodland. This vegetation type occurs on the banks, bottoms, and floodplains along major streams and rivers in the study area,

usually at elevations between 4,756 and 5,248 feet. Deciduous trees, growing along the Stillwater River and its tributaries, are the most prominent feature.

The riparian woodland type is dominated by a tree overstory composed primarily of black cottonwood intermixed with balsam poplar and quaking aspen. Other tall woody species include willows, alders, birches, common chokecherry, and red-osier dogwood. Shrubs, such as whortleleaf snowberry and Wood's rose, are found in the understory. Ground cover is provided by bluegrass, redtop, and cutleaf coneflower.

(6) Ravine Aspen-Chokecherry. This vegetation type is characterized by patches of quaking aspen and common chokecherry, which occur on slopes near seeps and springs or in areas where ground water is near the surface. This type differs from the streamside riparian woodland type in that it is not always associated with surface water and occurs on steep mountain slopes between 4,920 and 8,200 feet.

The overstory consists of quaking aspen intermixed with shorter woody species such as chokecherry, birch, and Rocky Mountain maple. Frequently occurring shrub species include whortleleaf snowberry, mountain ninebark, and horizontal juniper. Forb species include cutleaf coneflower, cow parsnip, meadow aster, and wartberry fairybells. Grass species are relatively unimportant in this vegetation type.

(7) Open Forest-Meadow Understory. This is a transitional type between forest and grassland types. It occurs on level areas to steep slopes, on all aspects, and at mid-elevations between 5,248 and 7,616 feet.

Scattered Douglas firs and limber pines are surrounded by dense herbaceous vegetation. Forb species are abundant and include arrowleaf balsamroot, spreading dogbane, field chickweed, and silvery lupine. Common grasses are bluebunch wheatgrass, bluegrass, Idaho fescue, and needle-and-thread. Dominant shrubs include mountain ninebark, horizontal juniper, skunkbush sumac, and fringed sagebrush.

(8) Open Forest-Rocky Understory. This transitional type occurs between forest vegetation types and bare rock outcrop, cliffs, and talus slopes. It is found on moderate to steep slopes at elevations between 4,838 and 8,856 feet. Scattered Douglas fir and limber pine trees are the dominant species, although ponderosa pine and lodgepole pine occasionally occur. Some shrubs found in significant amounts include common juniper, horizontal juniper, and mountain ninebark. Grasses and forbs contribute relatively minor amounts to the vegetative cover. Lichens are the dominant ground cover.

(9) Douglas-fir Forest. This type is located at elevations between 5,002 and 8,856 feet on level areas to steep slopes. Douglas fir is the dominant tree. The only frequently encountered shrub is common juniper. Forb species, such as spreading dogbane, loose-flowered milk vetch, and white spirea, contribute a small amount of vegetative ground cover. Grasses and sedges are present in small, often trace amounts.

(10) Lodgepole Pine Forest. The lodgepole pine forest type is frequently located on the bottom and sides of broad, U-shaped glaciated valleys from 6,232 up to 8,856 feet. Slopes are nearly level to steep. Lodgepole pine is the primary overstory species; however, Douglas fir grows in the more mature, open stands. Lodgepole pine is often considered to be a seral (temporary) species replaced gradually by Douglas fir, forming a Douglas-fir forest vegetation type at the climax (mature, stable) stage (Pfister et al., 1977). Limber pines are occasionally found growing within lodgepole and Douglas-fir stands.

Dense stands of lodgepole pine frequently have little or no understory vegetation. Plant growth is inhibited by a dense mat of pine needles and lack of sunlight. The more open stands contain a shrub understory of shrubs as common juniper, mountain ninebark, Wood's rose, and kinnikinnick. Lichens and mosses are often found beneath the woody overstory. Grasses and sedges contribute little to vegetative ground cover.

(11) Subalpine Forest. Vegetation within this type varies with topography, aspect, moisture, and soil. The type is located on mountain tops and slopes, glaciated valley sides, and basins between 7,052 and 8,856 feet in elevation.

The tree overstory is characterized by subalpine fir mixed with Engelmann spruce, limber pine, Douglas fir, and lodgepole pine. Vegetation beneath the trees varies with available soil moisture and divides the subalpine forest into three phases. The moist phase forest is dominated by a huckleberry understory. Forbs, in addition to huckleberry, differentiate the intermediate moisture phase. The dry moisture phase forest is characterized by common juniper, white spirea, and lichens.

(12) Revegetated Chrome Tailings. In the 1950s, Anaconda revegetated an abandoned tailing pond. Alfalfa contributes about half of the present vegetative cover. Yellow sweetclover grows among the alfalfa. Fringed sagebrush is common. Grass species include intermediate wheatgrass, bluebunch wheatgrass, and cheatgrass.

(13) Cultivated Hayland. This type is found in low-lying areas which are flood irrigated or subirrigated. It is used as pasture for livestock or for hay production. Major species are intermediate wheatgrass, alfalfa, timothy, orchard grass, and brome grass.

(14) Disturbed Lands. Included in this type are the old Mountain View townsites, the old chromite stockpile area, the reclaimed chrome concentrator site, and percolation ponds. SMC has added buildings, ore stockpiles, parking lots, and other facilities to the prior disturbances. Vegetation is highly variable and was not quantitatively examined during baseline inventories. Generally, reclaimed sites are visually dominated by alfalfa, yellow sweetclover, and wheatgrass. Other areas are in seral stages resembling the stony grassland or open forest-meadow understory types and contain introduced shrubs and forbs.

(15) Water. Surface water sources large enough for mapping are included in this type.

National Forest Timber Resources

Mining would affect some timbered areas within Custer National Forest. Predominant tree species are lodgepole pine, Douglas fir, and limber pine. The harsh sites and overstocked conditions limit growth. Most trees are pole sized or poorly formed small saw timber. All stands are of low commercial value due to poor quality timber and the rugged terrain's limits on harvest operations.

No significant quantities of timber have been harvested from the proposed or alternative disturbance areas. Some pole or prop material may have been cut from the proposed area during previous mining activities. There is no current plan for harvesting timber from the area and it is unlikely that timber will ever be of commercial value. The principle values of trees are for wildlife habitat, watershed protection, and scenery.

Noxious Weeds

Noxious weeds such as spotted knapweed and Canada thistle have been observed on old abandoned roads on the mountainside above the minesite facilities. No attempt has been made to reclaim these roads. They were built and abandoned before current state and federal reclamation laws were adopted.

AQUATIC ECOLOGY

Five streams lie near the proposed Stillwater Project: Stillwater River, West Fork of the Stillwater River, Verdigris Creek, Mountain View Creek, and Nye Creek. Aquatic invertebrate and periphyton information was obtained from a 1980-81 study prepared for Anaconda Minerals Company (CDM, 1981). During that study, ten aquatic sampling stations were established within the project area, including six stations on the Stillwater River, and one each on the West Fork of the Stillwater River, Verdigris Creek, Mountain View Creek, and Nye Creek (fig. III-8). Supplemental information was collected from the Montana Department of Health and Environmental Sciences, the Montana Department of Fish, Wildlife and Parks, the U.S. Forest Service, and the U.S. Fish and Wildlife Service.

The quality of aquatic habitats at the ten stations studied by CDM ranged from undisturbed conditions near station S-1 to habitats affected by wind-blown tailings at station NC-1 on Nye Creek. The aquatic habitats--including the riparian zone--of all stations located on the Stillwater River and the West Fork of the Stillwater River were in stable condition and exhibited stream habitat conducive to aquatic insect production.

Degraded aquatic habitats were found in the three tributary streams. Verdigris Creek contains elevated concentrations of metals that may result from the stream passing through an area of decomposed rock rich in oxidized metal pyrites. Suitable habitat for aquatic insect production is limited in the lower portion of Mountain View Creek because of chromium ore concentrates and in the lower part of Nye Creek because of mine tailings.

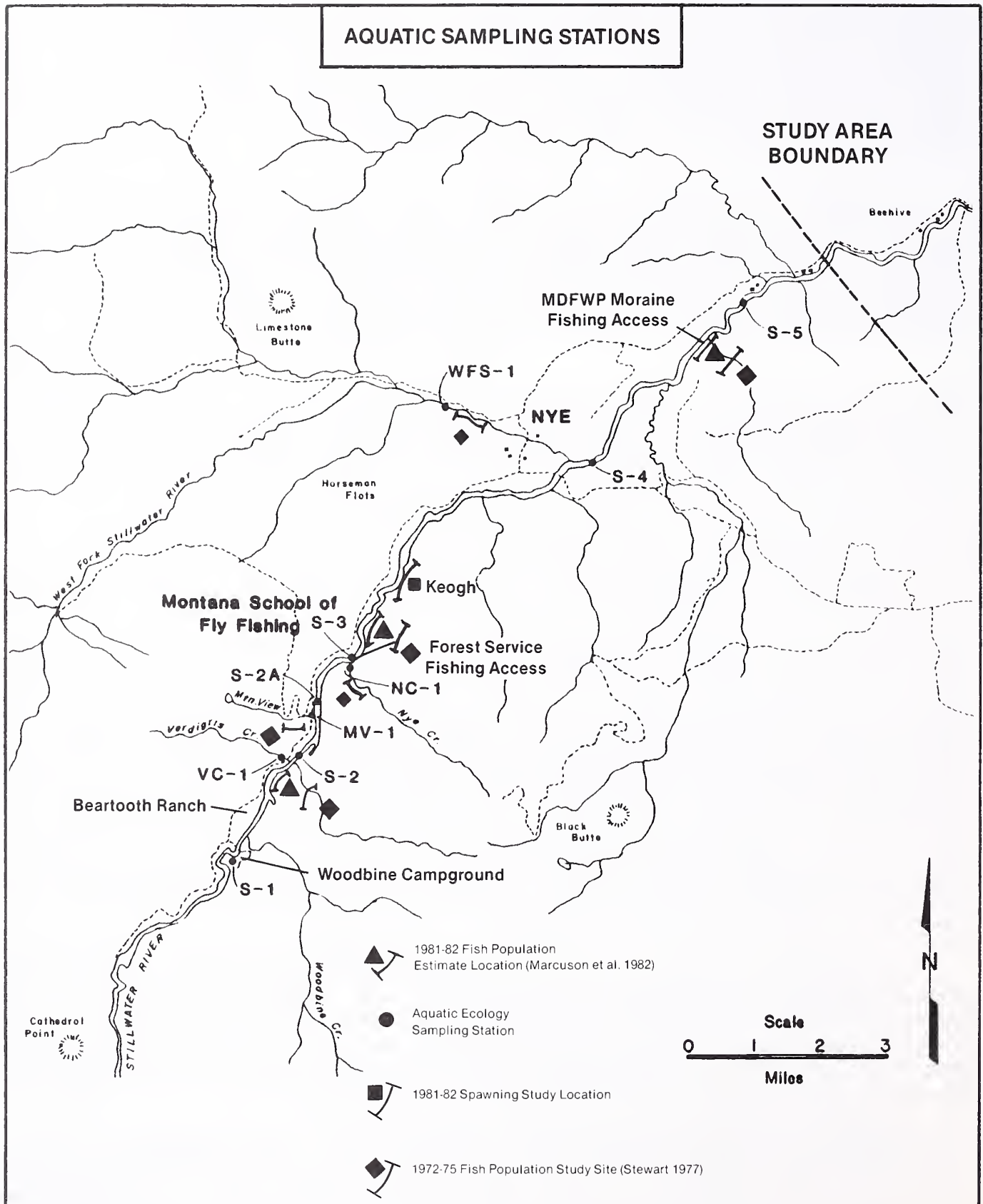


FIGURE III-8

A number of stations were established along the Stillwater River and its tributaries to assess aquatic habitat and fisheries. The West Fork and main stem of the Stillwater are of high aquatic quality, although in places Verdigris, Mountain View, and Nye creeks are degraded.

Aquatic Invertebrates

The aquatic invertebrate communities in the Stillwater River near the project area were found to be highly diverse and abundant. Densities of aquatic invertebrates ranged from 3,905 organisms per square meter at station S-2 to 29,290 organisms per square meter at station S-4. The density of organisms in the Stillwater River increased in a downstream direction. Between 17 and 46 different kinds of aquatic insects were collected at each of the stations located on the Stillwater River and West Fork of the Stillwater River.

Organisms collected included many that are sensitive to environmental degradation (e.g., the mayflies Rithrogena, Epeorus, Ephemerella, Heptagenia, and Pseudocloen; the stoneflies Chloroperlidae and Nemouridae; and the caddisflies Rhyacophila and Arctopsyche). Their presence indicates good water quality and good aquatic habitat conditions. The aquatic insect communities were also functionally diverse (Cummins, 1978) with representative algae scrapers (Baetis, Epeorus), predators (Isoperla and Rhyacophila), collectors (Ephemerella) and filter feeders (Arctopsyche and Simulium) found throughout the study area.

The diversity of aquatic invertebrates found within the tributary streams was lower than in the Stillwater River. Mountain View Creek was the most diverse of the three tributary streams with 21 invertebrate organisms, followed by Verdigris Creek with seven and Nye Creek with six. The paucity of aquatic insect types in these streams was probably directly related to the quality of aquatic habitats.

Periphyton

Periphyton is a group of a variety of organisms, including bacteria, protozoa, and algae, that are attached to rocks, plants, or other stream substrates. Data collected during three sampling periods (spring, summer, and fall) in the Stillwater River and the West Fork of the Stillwater River indicate a diverse periphyton community.

Diversity indexes ranged from approximately 1.2 at S-1 to 3.5 at S-5. The diversity index tends to be high when there is a large number of species and when individuals are evenly distributed. Within the study area, diversity was highest in downstream reaches of the Stillwater River and at the sampling station on the West Fork of Stillwater. The dominant taxonomic groups of periphyton found included the Bacillariophyta (diatoms) and Chrysophyta (yellow-green algae). These two groups made up from 13 to 93 percent (diatoms) and from 0 to 81 percent (yellow-green algae) of the total periphyton collected during the three sampling periods. Cyanophyta (blue-green algae) and Chlorophyta (green algae) were important components during the summer samplings: Blue-green algae species made up as much as 65 percent, and green algae as much as 52 percent, of the total number of organisms present at any one station. Green algae were also important during the fall sampling, composing as high as 56 percent of the total numbers per station. Other taxonomic groups such as Euglenophyta (euglenoids) and Pyrrophyta (dinoflagellates) were only minor components of the samples.

Several of the periphyton species collected are indicators of good water quality. The diatom Achnantes minutissima was one of the most abundant organisms sampled and is an indicator of high dissolved oxygen concentrations. The yellow-green alga Hydrurus foetidus was also abundant and is characteristic of streams having good water quality, high velocities, and cool temperatures. The dominance of diatoms at most stations in the Stillwater River and West Fork of the Stillwater River is characteristic of aquatic ecosystems that are largely undisturbed.

FISHERIES

The Montana Department of Fish, Wildlife, and Parks considers both the Stillwater River and its West Fork, both near or downstream from proposed mining operations (fig. III-8), to be "substantial fishery resources." Stewart (1977) used electrofishing to sample fish populations in both streams. The same technique was employed by Marcuson et al. (1982) to re-examine the Stillwater River. These reports are summarized below.

Stillwater River

The 1981-82 study area consisted of three population estimate stations and one brown trout and whitefish spawning study station (fig. III-8). Population estimate stations roughly corresponded to sites used in the early 1970s. Spawning study sites were also located below the town of Absarokee.

Electrofishing studies focused on brown trout, rainbow trout, brook trout, and mountain whitefish. (See appendix F for scientific names.) These game species make up most of the fish biomass in the Stillwater River. Cutthroat trout were last collected in 1974. Rainbow-cutthroat hybrid trout are infrequently encountered. Nongame fish present throughout the river include longnose sucker, mountain sucker, longnose dace, and white sucker. Mottled sculpin and shorthead redhorse inhabit the mouth of the river.

The composition of game fish in the study area varies seasonally. Brown trout and whitefish are the most common fish in the area in the fall. In spring, rainbow trout increase in number. Just the reverse is true in the lower Stillwater River (below Absarokee), from where the species migrate. The year-long average species composition of the study area was 35 percent brown trout, 33 percent mountain whitefish, 27 percent rainbow trout, and 5 percent brook trout. In the lower river, the comparable composition was 50 percent whitefish, 27 percent brown trout, and 13 percent rainbow trout.

Brown trout densities in the study area increased from 184 yearling and older fish per 1,000 feet of river in the spring to 215 per 1,000 feet in the fall, a 16.8 percent increase. The density of fish in the favored spawning areas within the study area increased 84 percent from spring to fall. Browns tended to move upstream into the study area to spawn, then gradually shifted back downstream. The longest distance traveled by a brown was 56 miles.

A resident population of 309 rainbow trout per 1,000 feet of river existed in the upper reaches of the study area. The fall population consisted mainly of offspring of migrant spring spawners, some stocked fish, and a few residents. Seventy percent of the entire rainbow population were young of the year, 17 percent were age 1, and 13 percent were age 2 or older. The lower river had a fall density of 142 rainbows per 1,000 feet. The catch of yearling or older rainbows per unit effort (CPUE) per 1,000 feet was four during the fall and nine during the spring in the study area. In the lower Stillwater, the CPUE was seven in spring and four in the fall. Ninety percent of all juvenile rainbows sampled in the entire river were found in the study area.

Migrant rainbow trout from the Yellowstone and lower Stillwater Rivers began moving into the study area the third week of April. Their numbers peaked on April 29 and their spawning ended by May 12. Return downstream followed spawning.

In the study area, the proportion of spawning-size rainbow trout (12 inches and larger) increased from 3 percent in the fall to 40 percent in the spring (fig. III-9). The percent of spawning-size rainbows in the entire Stillwater River during the fall was 16.2, while in the spring it was 30.5, indicating that about 47 percent of the spawners in the Stillwater River migrate up from the Yellowstone River. Of the 14 captured and marked rainbow that migrate between the study area and areas downstream, 64 percent moved to or from the lower Stillwater River, while 36 percent moved to or from the Yellowstone River.

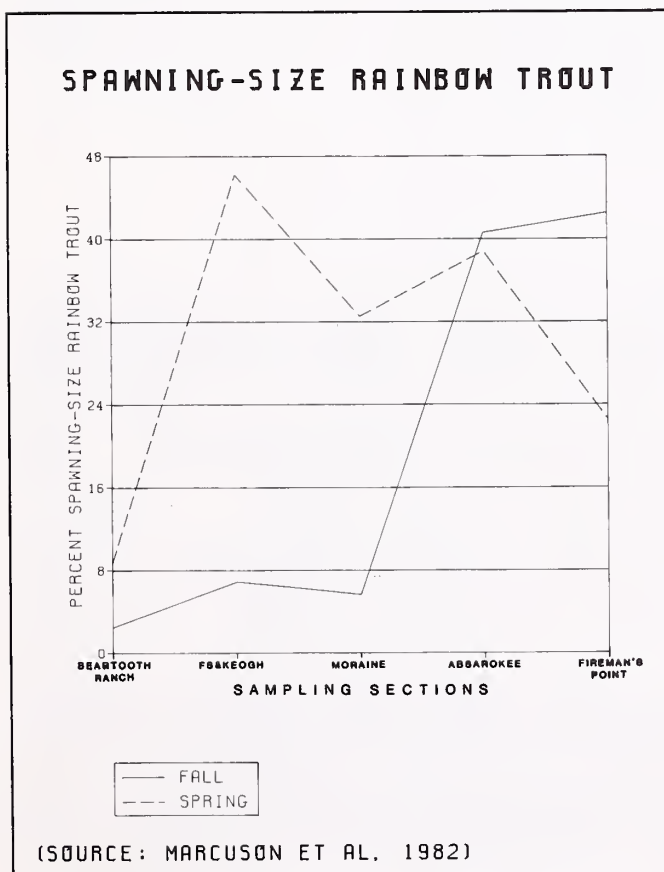


FIGURE III-9

Near the project area, the percentage of rainbow trout of spawning size varies markedly. (The Absarokee and Fireman's Point sites are downstream of the town of Absarokee.)

Mountain whitefish densities increased from 39 to 291 per 1,000 feet from spring to fall in the study area, a 646-percent increase. No extreme movements were observed; marked fish tended to shift upstream to favored spawning sites in mid-October. Juveniles emerged in February, drifted downstream, and began a gradual upstream trek as water temperatures increased to 48°F during spring discharges preceding the June runoff.

The 3-year, 1972-1974, mean density of brook trout was 93 per 1,000 feet in the study area. The mean CPUE for these 3 years was 4 per 1,000 feet. No estimates were made in 1981, due to low densities. The mean CPUE in 1981 was 0.3 per 1,000 feet. Only four brook trout were captured in 18 electrofishing runs in the lower Stillwater.

The nature of the gravel substrate, shallow side channels, flow regimens, water quality, and stream gradient make the river in the study area ideal for spawning and rearing of game fish that live in the lower Stillwater and Yellowstone Rivers. The river environment downstream from Beehive, Montana, is suitable for year-round occupancy, but does not provide the ideal spawning and rearing habitat of the study area.

West Fork of the Stillwater River

Electrofishing revealed that brown trout, rainbow trout, brook trout, and mountain whitefish inhabit the lower West Fork of the Stillwater River. Population estimates were made only for the more prevalent brown and rainbow trouts. The West Fork supports about 300 brown trout and 100 rainbow trout per 1,000 feet of stream. Five percent of the browns had reached at least age 3, averaging 12.6 inches long. Rainbows attaining age 2 or more, 58 percent of the population, averaged 7.8 inches long.

WILDLIFE

This section is based on wildlife studies conducted by the Montana Department of Fish, Wildlife, and Parks (MDFWP) and Camp Dresser and McKee (CDM), a consulting firm. The MDFWP reported primarily on deer, elk, and bighorn sheep (Youmans, et al. 1982; Stewart, 1984.) Marked or radio-collared animals were monitored from 1980 to 1982 to determine distribution and movements. Other MDFWP publications provided supplementary big game information. A one-year baseline inventory supplied information on other wildlife species and wildlife habitats (CDM, 1981). All reports are on file with the Department of State Lands and available for public review. The areas studied by MDFWP and CDM are shown in figures III-6 and III-10.

The Stillwater wildlife study areas support diverse and abundant wildlife populations. During the baseline inventory, 143 bird, 34 mammal, 6 reptile, and 1 amphibian species were observed. Important winter ranges for elk, mule deer, and bighorn sheep occur within the study area. (See appendix G for scientific names of wildlife species.) Vegetation types and topography

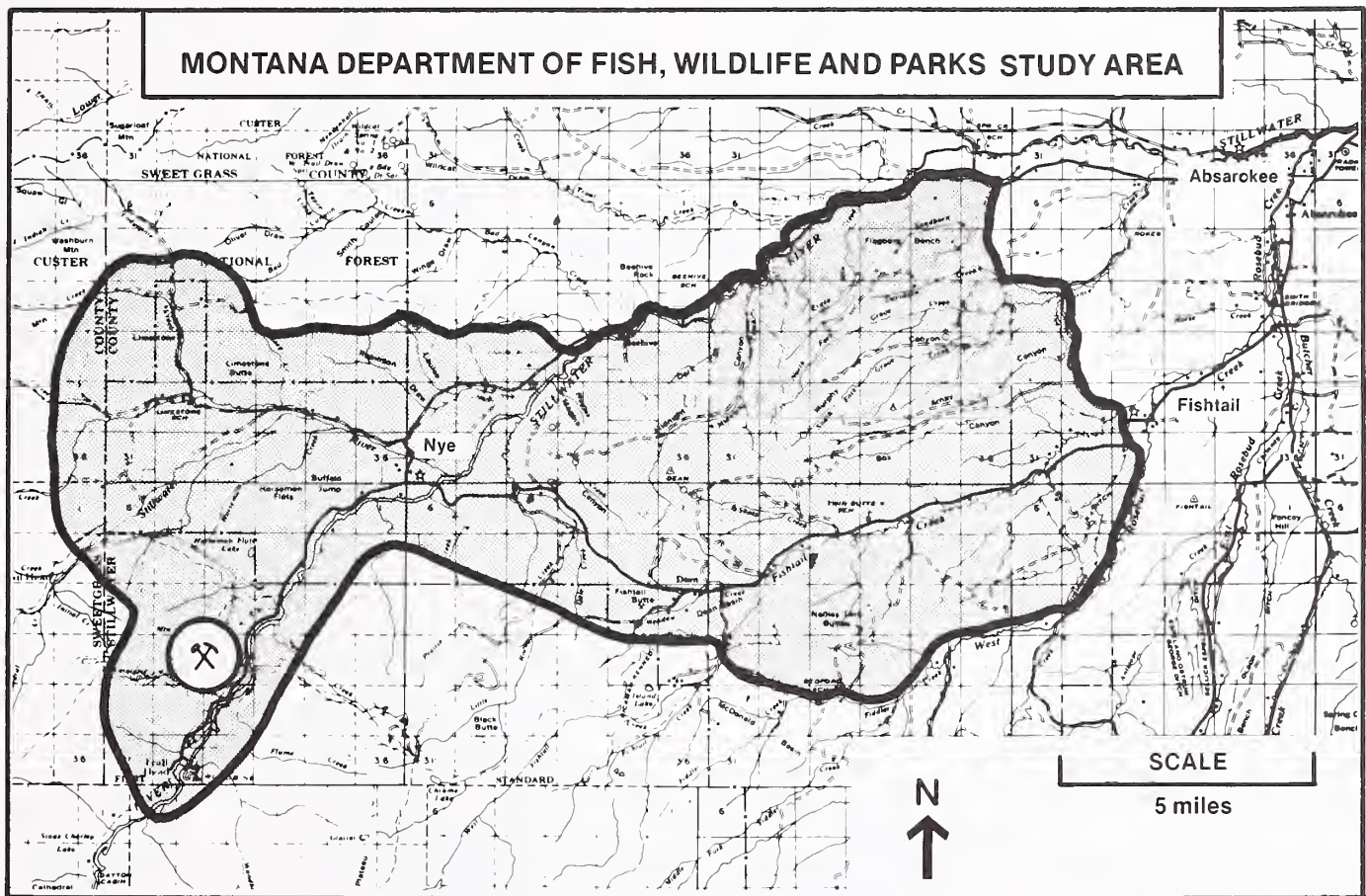


FIGURE III-10

For wildlife studies, the Department of Fish, Wildlife, and Parks analyzed a larger area than did Camp Dresser and McKee (fig. III-6). The Department of Fish, Wildlife, and Parks studied big game.

combine to meet the habitat requirements of various species. Wildlife habitat types (table III-4 and fig. III-11) correspond to vegetation types previously described. (See Vegetation.) The open Douglas-fir forest and the stony grassland habitat types make up over half the CDM study area.

Big Game Species

Mule Deer

Mule deer were the most common big game animal in the MDFWP study area, particularly during the winter. The population of mule deer was estimated at 5,900 during the March 1982 survey. Densities varied by survey unit from 18 to 82 per square mile (table III-5).

Total numbers of mule deer in the area are affected by winter conditions. The 1980-81 winter was relatively mild. Some deer may not have moved into the area because they found adequate food and shelter elsewhere. Somewhat harsher weather in 1982 corresponded with increased numbers of deer. Youmans et al. (1982) believe that a severe winter would further increase deer numbers.

TABLE III-4

Wildlife Habitat Types and
Corresponding Vegetation Types in the
CDM Wildlife Study Area

Wildlife Habitat Types	Acres	Percent of Study Area	Corresponding Vegetation Types
Boulder and Talus Field	189	1	Open Forest-Rocky Understory
Closed Douglas-fir Forest	2,070	9	Douglas-fir Forest
Closed Douglas-fir/ Lodgepole Pine Forest	161	1	Lodgepole Pine Forest
Closed Lodgepole Pine Forest	1,576	7	Lodgepole Pine Forest
Hay Meadow	1,328	6	Cultivated Hayland
Disturbed Forest	161	1	Open Forest-Meadow Understory Lodgepole Pine Forest
Disturbed Grassland	184	1	Revegetated Chrome Tailings
Disturbed Meadow	<1	T	Open Forest-Meadow Understory
Disturbed Shrubland	5	<1	Revegetated Chrome Tailings
Drainage Bottom Meadow	267	1	Drainage Bottomland
Mosaics	479	2	--
Open Douglas-fir Forest	7,265	32	Open Forest-Meadow Understory Open forest-Rock Understory
Palustrine	30	1	--
Ravine Aspen	557	2	Ravine Aspen-Chokecherry
Riparian Woodland Meadow	1,134	5	Riparian Woodland
Rocks Cliffs/Benches	806	4	Douglas-fir Forest, Open Forest-Rocky Understory
Sagebrush Shrubland	324	1	Sagebrush Shrubland
Skunkbush Shrubland	615	3	Skunkbush Shrubland
Stony Grassland	5,323	23	Stony Grassland
Upland Grassland	338	1	Stony Grassland
TOTAL	22,812	100 ²	

Source: Camp Dresser and McKee, 1981.

¹ Mosaics represent the edge between two or more habitat types and do not have a corresponding vegetation type.

² Rounded to 100 from 101.

The mule deer population appears to be increasing. Production rates were high during fall 1981, when there were 78 fawns per 100 does. Few fawns died during the preceding winter (Simmons et al., 1981). As a result, a large percentage of the deer were yearlings during 1981. Of the adult males captured and marked, none were older than 2 1/2 years. This may result from an inability to capture older males, unusually high death rates of older males, or emigration.

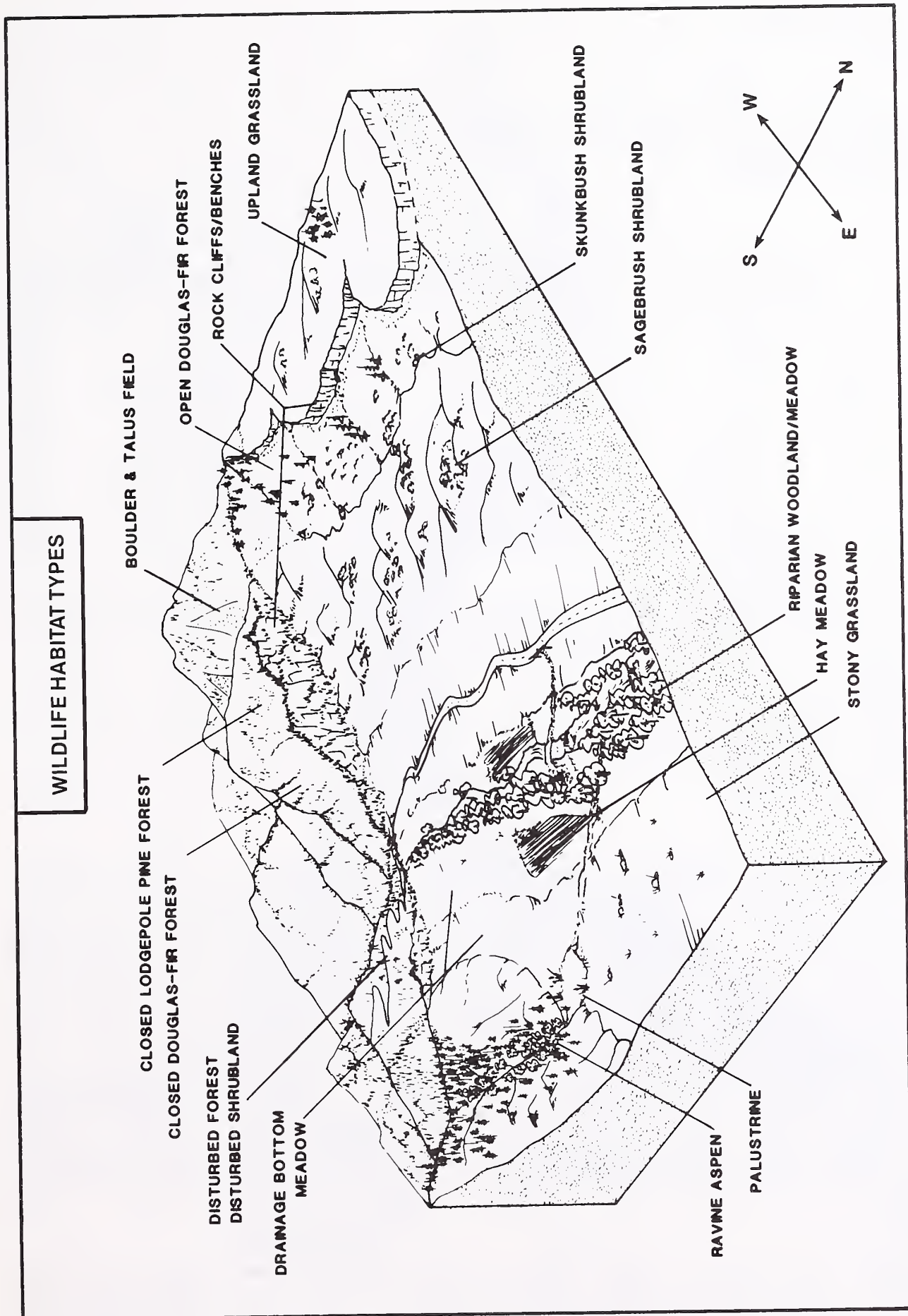


FIGURE III-11

Wildlife habitat types correspond to vegetation types. The most common habitat types are Douglas-fir forest and stony grassland.

TABLE III-5

Mule Deer Population Estimates
by Helicopter Survey Unit, MDFWP Study Area
March 1981 and 1982

Survey Unit	Unit Size (square mile)	Population Estimates		Densities (deer/square mile)	
		1981	1982	1981	1982
1	16	1,157	1,318	72	82
2	15	443	406	30	27
3	7	71	124	10	18
4	13 ₁	292	204	22	16
5	6 ¹	328	916	55	44
6	36	490	884	14	25
7	18 ₂	822	1,351	46	75
8	9 ²	321	597	36	63
TOTALS	120 ³	3,924	5,800	33 ⁴	43 ⁴

Note: Estimates by the Lincoln-Petersen Index, based on the proportion of marked animals observed (Overton and Davis, 1969).

¹Enlarged to 21 square miles in 1982.

²Enlarged to 11 square miles in 1982.

³Enlarged to 137 square miles in 1982.

⁴Mean total density.

Observation of marked deer allowed the identification of four distinct winter range units: (1) Beartooth, (2) Keogh, (3) Limestone, and (4) Stillwater (fig. III-12). Deer from different winter ranges exhibited different migratory patterns. Movements of three does from the Beartooth unit indicated the migratory nature of that unit's deer. These individuals moved south along the Stillwater River, reaching the Slough Creek Campgrounds (in Yellowstone National Park) in late May. Does inhabiting the Keogh and Stillwater units have small home ranges. Although some bucks migrate, most deer probably reside year-round in these two units. Seasonal movements of deer in the Limestone unit have not been classified. However, a few marked animals made extensive movements to the northeast, leading Youmans et al. (1982) to speculate that at least some Limestone unit deer summer in the drainages of the East Boulder River. Additionally, the animals in the unit have the largest winter-spring movements. Most migratory deer return to winter ranges by mid-December.

Habitat use by deer was separated into spring/summer and fall/winter sightings. Two types of data collection (vehicle/pedestrian and aerial surveys) were used and yielded different results. During spring and summer, 41 percent of ground observations were made in the stony grasslands, while 30

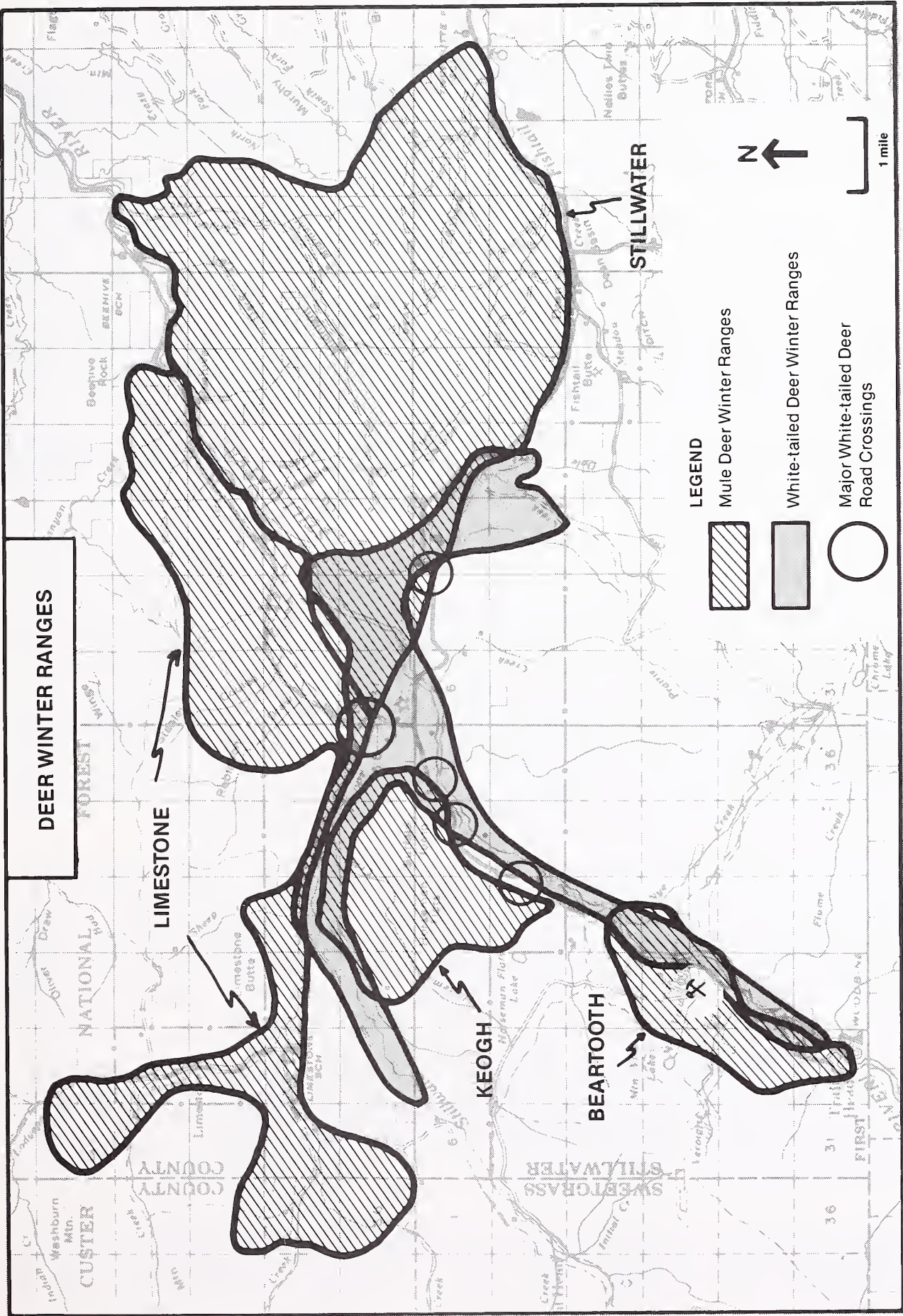


FIGURE III-12

Mule deer use four distinct winter ranges. White-tailed deer use one contiguous range along the valley bottom. Five sites in the valley bottom have been identified as major road crossings for deer.

percent were made in hay meadows. Aerial surveys differed considerably; upland grasslands (26 percent) and sagebrush shrublands (25 percent) accounted for most observations. Aerial surveys indicated a lower use in stony grassland (15 percent) and higher use of skunkbush shrublands (17 percent) and open Douglas-fir forests (13 percent).

The results of ground surveys during fall and winter were similar to spring and summer surveys. Use of stony grassland was essentially the same (41 percent), although sightings in hay meadows decreased somewhat (21 percent). Use of open Douglas-fir types increased (12 percent). Results of aerial surveys were again different from ground surveys. The highest use shown by this technique was in open Douglas-fir forests (32 percent). Sagebrush shrublands were used 21 percent of the time, upland grasslands 19 percent of the time, and stony grasslands 13 percent of the time.

Differences in results between aerial and ground surveys were probably due to observer bias, differences in observability due to type of technique used, and observability differences between habitats.

White-tailed Deer

During the 1800s white-tailed deer were described as "fairly abundant" in the Beartooth Mountains; by 1910 they had dwindled to "very scarce" (Cooney, 1936). The Montana Department of Fish and Game transplanted whitetails to the Beartooth Mountains from 1945-1947. Approximately 20 deer were released near the Beartooth Ranch during two years (1945 and 1946). The total population was estimated at 100 in 1949 (Stoneberg, 1977). A population estimate using marked deer was conducted on March 17, 1982, by Montana Department of Fish, Wildlife, and Parks personnel. The department estimated that 251 animals were within the area, a density of 19 white-tailed deer per square mile.

Stoneberg (1977) described whitetail range as a wide corridor along the Stillwater River between Nye Creek and Little Rocky Creek and another corridor along the West Fork of the Stillwater to Horseman Flats (fig. III-12). White-tails have also been observed as far south as Woodbine Campground and as far north as the Meyer Creek area. Although six of seven radio-collared animals limited winter (1982) movements to less than a square mile, some neck-banded individuals traveled up to 2 miles from their capture sites. Movements increased during spring; two radio-collared does moved 15 to 22 miles northeast of Nye. Additional observations of marked deer indicate that, at least during spring, whitetails use habitats outside the range identified by Stoneberg (1977). Deer from the Stillwater population were sighted 22 to 32 miles southeast of Nye. Five deer crossings have been identified on roads north of the proposed mine (fig. III-12).

Fawn production rates were excellent during 1981. Fall counts indicated 125 fawns per 100 does. Spring surveys conducted in hunting districts 520 and 572, containing the Stillwater study area, revealed the highest fawn:adult ratio in recent years (Simmons, 1981).

Habitat use, as determined by aerial surveys, was concentrated in three habitats. In spring and summer white-tailed deer used stony grassland 63 percent of the time, hay meadows 23 percent of the time, and riparian woodland meadows 5 percent of the time. In fall and winter whitetails used stony grasslands 15 percent, hay meadows 38 percent, and riparian woodland meadows 31 percent of the time. Riparian habitat use was probably underestimated because of the low visibility within this habitat.

Bighorn Sheep

Bighorn sheep in the upper Stillwater River Valley have been studied since 1971 (Stewart, 1975; Stoneberg, 1977; CDM, 1981; Youmans et al., 1982; Stewart, 1984). Stoneberg (1977) reviewed USFS and MDFWP population data and made almost daily winter-spring observations from 1971 through 1976. Since 1976, bighorn observations have been made at approximately weekly intervals. The studies reveal that herd size peaked in 1977-78 at 60 animals, then dropped to 51 to 55 animals (table III-6). The 1982-83 census revealed a further decline in population and lamb:ewe ratios. The population increased slightly in 1983-84, although lamb:ewe ratios remained the same. Both population and lamb:ewe ratios remain above those recorded in the 1950s and 1960s. Stoneberg (1977) stated: "It appears 40-50 sheep was the carrying capacity" of bighorn winter range. Youmans et al. (1982) and Stewart (1984) noted that low lamb:ewe ratios occurred during mineral exploration activities.

The major winter concentration area for bighorn sheep lies between the Mouat Mine and Woodbine Trailhead, along the west side of the Stillwater River (fig. III-13). This winter range covers only about three square miles and is used by all members of the Stillwater herd at some time during the winter. A peripheral winter range, used by fewer than 10 bighorn, is found on the east side of the Stillwater River (fig. III-13). Most bighorns arrive on the winter range by mid-October and stay for 8 to 9 months. All rutting (mating) activities occur on the major winter range. Important areas during the rut are the cliff south of SMC headquarters, the Woodbine Trailhead vicinity, and the Stillwater Canyon north of Verdigris Creek. After the rut, mature rams separate from the rest of the herd and use reclaimed mine roads near Verdigris Creek. They do not mix with the other bighorns until a three-week period in March and April. The peripheral winter range is generally not used by mature rams.

Ewes begin moving off the winter range to lambing grounds in early June. They move south along the Stillwater River into the lambing grounds along the Flood Creek drainage. Some ewes may lamb at Cathedral Point. During the summer, ewes remain in Flood Creek drainages and also use alpine basins near Two Sisters. They periodically visit old mine roads within the winter range. Fall range resembles summer range.

Rams also move south along the Stillwater River in early June. They travel west from Flood Creek drainages and Wounded Man Creek to the Lake Plateau and Columbine Lake area. Later, the rams move farther west, crossing the East Fork of the Boulder river. Some animals may reach the Hellroaring Creek drainage, over 50 miles from their winter range. Ram fall range is similar to ewe fall range, although rams do not intermingle with the ewes.

TABLE III-6

Post-Hunting Season Counts of
the Stillwater Bighorn Population,
1950-1984

Year	Lambs per 100 Adult			Total	Mining Activity in Mouat Area	Source ¹
	Rams	Ewes	Lambs			
1950s	8	24	7	40 ²	Chrome mining: 1952-61	MDFWP Files
1960s	4	17	5	25 ²	Intensive copper-nickel exploration in 1967	MDFWP, USFS Files
1970	2	21	5	28	Undocumented	MDFWP Files
1971-72	4	18	11	33	"Enough activity to main- tain valid mining claims"	Stoneberg (1977)
1972-73	6	22	14	42	"Enough activity to main- tain valid mining claims"	Stoneberg (1977)
1973-74	7	25	15	47	"Enough activity to main- tain valid mining claims"	Stoneberg (1977)
1974-75	8	27	11	46	"Enough activity to main- tain valid mining claims"	Stoneberg (1977)
1975-76	7	28	9	44	"Enough activity to main- tain valid mining claims"	Stoneberg (1977)
1976-77	11	27	12	50	Undocumented	Stoneberg (1977)
1977-78	13	31	16	60	Undocumented	Youmans et al. (1982)
1978-79	12	25	15	52	Undocumented	Stewart (1984)
1979-80	17	26	8	51	AMC exploration at Mouat mine begins	Youmans et al. (1982)
1980-81	14	27	11	52	AMC exploration continues	Stewart (1984)
1981-82	18	26	11	55	AMC exploration continues	Youmans et al. (1982)
1982-83	16	20	6	42	Maintenance activity ³	Stewart (1984)
1983-84	23	19	6	48	SMC exploration begins	Stewart (1984)

¹ 1950-1975 data summarized in Stoneberg (1977).

² Data is averaged over several years. Therefore, columns 2-4 do not add up to figures in the total column.

³ Activity limited to caretaking around SMC headquarters (Les Darling, SMC, pers. com., September 12, 1984).

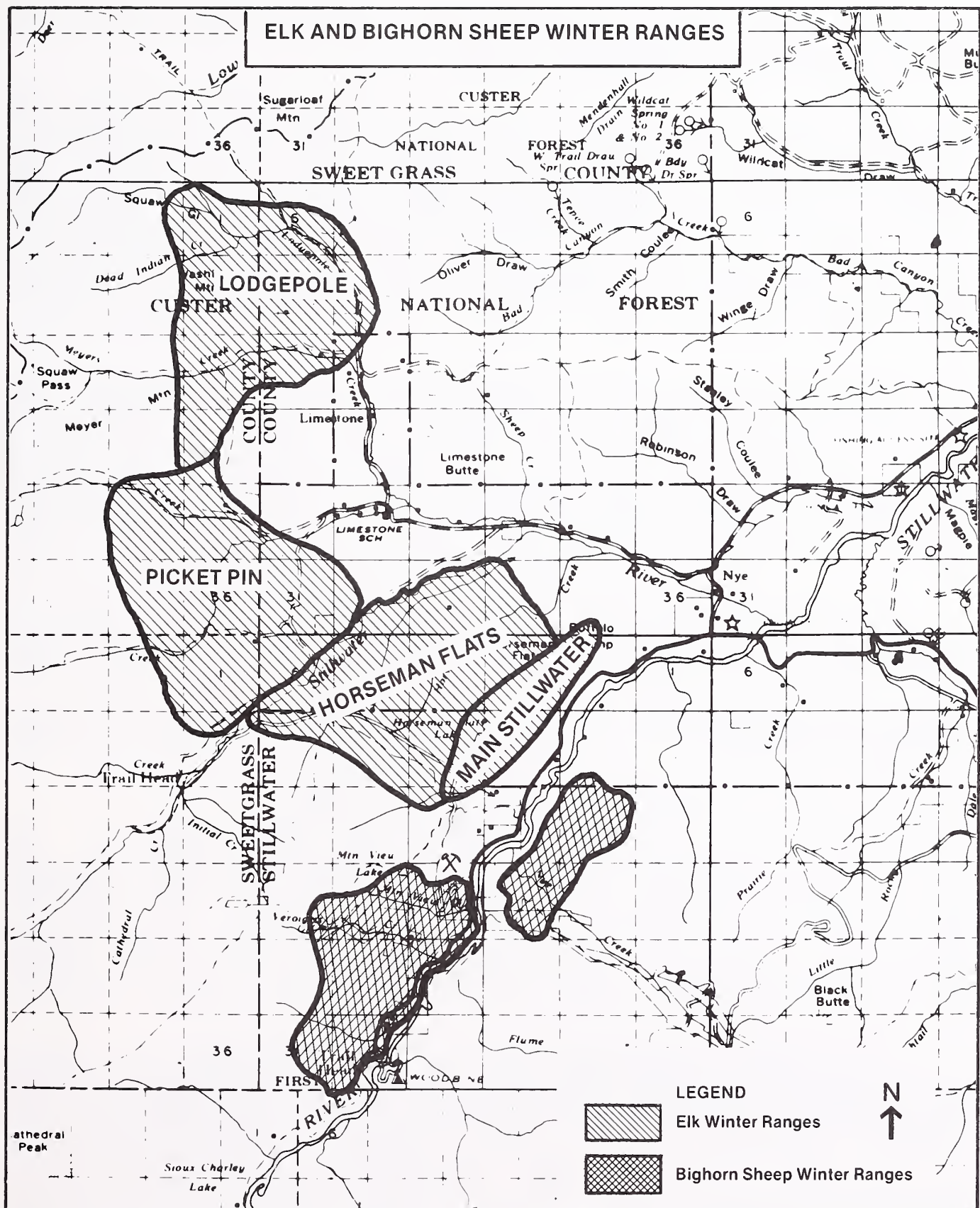


FIGURE III-13

Bighorns use their winter range for eight or nine months, starting in mid-October. All mating takes place on the winter range. Elk in the study area use four winter ranges; none adjoin the project area.

The use of seasonal ranges, travel routes, and lambing grounds is traditional. Knowledge of these areas is gained by young bighorns as they follow older, usually larger-horned, individuals (Geist, 1971).

Winter observations of four collared ewes allows comparison of home range sizes among years (table III-7). Data indicate that three ewes probably increased home ranges in 1979-80. Home ranges of these animals remained large through succeeding winters with the exception of ewe 01, whose movements were limited by injury. One ewe maintained a small range within the escape terrain of a rocky area. The Department of Fish, Wildlife, and Parks (pers. com., August 5, 1982) believes that data in table III-7 represent changes in most of the herd. They suggest that mining-related human activity is responsible for the expanded home ranges of three ewes and the restriction of a fourth ewe to escape terrain.

Winter habitat use by bighorn now differs from patterns observed in 1974-75 (table III-8). The Idaho fescue/bluebunch wheatgrass and skunkbush sumac/bluebunch wheatgrass habitat types (Stewart, 1975) formerly accounted for 50 percent of observations. The Idaho fescue/bluebunch wheatgrass type produces the highest quality forage (Stewart, 1975). By 1983-84, use of this type and the skunkbush sumac/bluebunch wheatgrass type had declined to 21 percent. Youmans et al. (1982) state that bighorn are responding to increased vehicle traffic by avoiding favorable foraging areas near the highway.

Observations made by CDM (1981) in 1980-81 present a different picture of habitat use. During ground surveys (1,190 observations), the drainage bottom meadow type was used year-round by over 60 percent of the bighorns. Sample size was smaller for aerial surveys (80 animals observed), which revealed that stony grasslands were often used (63 percent of spring/summer and 34 percent of fall/winter observations). CDM indicates that stony grasslands are roughly equivalent to Stewart's (1975) Idaho fescue/bluebunch wheatgrass type. Other important bighorn habitats were cliffs and open forests.

Between 1971 and 1982, an average of 12 lambs per year were born. (The average has declined to 10 due to low 1983 and 1984 production; see table III-7). About 59 percent of lambs died during their first year. Mortality rates averaged 12 percent for two- to four-year-old ewes and 27 percent for ewes five to nine years old. Few ewes live past ten years. Hunting controls ram mortality. Before a quota system was implemented, most rams were harvested at three years of age and none lived past five years. Rams now may live to over eight years old.

The Stillwater bighorn herd exists in conditions similar to those of inbred populations. Inbred herds are often small, isolated populations with reduced numbers of breeding males. They are adapted to a narrow set of environmental conditions due to low genetic diversity. Stillwater rams exhibit relatively small horn sizes (Stewart and Butts, 1982) and lamb crops have declined since 1982 (Stewart, 1984). Inbreeding has been noted as a limiting factor in horn growth (Stewart and Butts, 1982) and herd productivity (Farnsworth, 1978, in Skiba and Schmidt, 1982).

TABLE III-7

Home Range Sizes for Four Bighorn Ewes
During Winters, 1976 through 1982
(square miles)

Ewe Number		1976-77 ¹ (Mild)	1977-78 (Moderate)	1978-79 (Severe)	1979-80 (Mild)	1980-81 (Mild)	1981-82 (Moderate)
01 ²	Home Range Size (mi. ²)	0.02	0.28	0.16	0.64	0.21	--
	No. of Observations	4	8	15	14	7	0
02	Home Range Size (mi. ²)	--	0.01	0.17	0.89	0.65	0.58
	No. of Observations	0	5	16	16	21	17
59	Home Range Size (mi. ²)	0.32	0.19	0.91	0.26	0.13	0.30
	No. of Observations	9	8	14	15	9	12
66	Home Range Size (mi. ²)	0.20	0.11	0.16	1.10	1.57	0.50
	No. of Observations	8	8	16	14	24	18

¹General weather conditions.

²Ewe 01 was injured during 1980-81 and was dead by 1981-82.

TABLE III-8

Habitat Use by Bighorn During Winter
1974-75 to 1983-84

Year	Percent Observed in Habitat Type								Sample Size ⁴
	FEID/ AGSP	RHTR/ AGSP	ARTR/ AGSP	PSME/ AGSP	PSME/ FEIS	Rock	Misc. ²	Other ³	
1974-75	33	17	8	4	1	10	0	27	4,362
1980-81	19	8	2	2	2	5	1	61	1,612
1981-82	9	8	Tr. ⁵	4	Tr. ⁵	2	4	72	2,035
1982-83	13	2	0	3	1	9	1	71	546
1983-84	12	9	1	8	0	4	--	65	336

¹Habitat types after Stewart (1975). Codes: FEID/AGSP = Idaho fescue/bluebunch wheatgrass, RHTR/AGSP = Skunkbush sumac/bluebunch wheatgrass, ARTR/AGSP = Big sagebrush/bluebunch wheatgrass, PSME/AGSP = Douglas fir/bluebunch wheatgrass, and PSME/FEIS = Douglas fir/Idaho fescue.

²Includes river bottom and reclamation area.

³Calculated by subtracting observed bighorn from estimated total population.

⁴Based on population estimate; includes bighorn not observed.

⁵Less than 1 percent.

Elk

Indications of elk use in the upper Stillwater Valley area date back to the early 1900s. A small group of elk used the Horseman Flats and areas to the west from the late 1940s to the 1960s. This herd increased substantially in the late 1960s. The increase is apparently continuing during the 1980s. The highest winter herd counts were 86 in 1981 and 104 in 1982.

Stoneberg (1977) identified three elk winter ranges: Stillwater, Horseman Flats and Picket Pin (fig. III-13). He located calving areas along Rabbit Gulch and Horsehead Draw within the Horseman Flats unit. Youmans et al. (1982) identified an additional winter range north of the Picket Pin unit and centered near the Meyers Creek Ranger Station. Few observations were made on this range, the Lodgepole unit, until 1980. Development of the Lodgepole winter range and declining use of the Horseman Flats and Stillwater units suggest that elk are shifting their winter distribution to the north. Elk travel to summer ranges as distant as the Breakneck Plateau and Placer Basin during May through July. Movement back to winter ranges begins in October and November.

Other Big Game Species

Other large mammals were not intensively studied. Most information is based on incidental sightings made during other wildlife investigations.

(1) Black bear--Seven bears used southeast-facing slopes between the Beartooth and Stratton ranches during spring 1981. An additional 13 bears were located in drainages near the Meyers Creek Ranger Station.

(2) Moose--Little information on moose is available. Recent observations have been limited to one animal at the Woodbine Trailhead and a small group along Fishtail Creek. Moose populations in the Stillwater Valley were apparently greater prior to the 1950s. Current moose range lies southeast of the wildlife study areas.

(3) Mountain goat--A mountain goat herd was introduced and established south of Woodbine Campground. One goat was repeatedly sighted on cliffs east of the Stillwater River at the southern end of CDM's study area. The closest group of goats came within 3 miles of the study area's southern boundary.

(4) Mountain lion--Two mountain lions were observed in separate observations in the fall of 1980. In January 1981 one adult female and one young lion were sighted feeding in a Douglas-fir forest.

Small and Medium-Sized Mammals

Small and medium-sized mammals are important prey for raptors and mammalian predators. Eleven species of rodents were trapped; however, 90 percent of the captures were deer mice, which were captured in all habitats. Other common species included the Gapper's red-backed and long-tailed vole and the yellow-pine chipmunk (table III-9). Also trapped were the water vole, the least chipmunk, the bushy-tailed woodrat, and three species of shrews.

TABLE III-9

Observed and Expected Numbers of Common Small Mammals Trapped in the Stillwater Study Area

Habitat	Deer Mouse		Gapper's Red-backed Vole		Yellow-pine Chipmunk		Long-tailed Vole	
	Obs. ^a	Exp. ^b	Obs. ^a	Exp. ^b	Obs. ^a	Exp. ^b	Obs. ^a	Exp. ^b
Boulder & Talus, Rock Cliffs/ Benches	409	118	0	3.7	0	1.6	0	1.7
Forest	625	1,035	49	32.1	14	13.7	11	14.8
Shrubland	222	83	0	2.6	0	1.1	4	1.2
Grassland/Meadow	207	529	0	16.4	2	7.0	0	7.5
Disturbed/Cultivated	404	148	11	4.6	22	2.0	0	2.1
Riparian/Palustrine	166	104	3	3.2	0	1.4	14	1.5
TOTAL	2,033	2,017	63	62.6	27	26.8	29	28.8

Note: To increase sample size, habitat types have been grouped according to the main structural component of each type.

^a Obs.=Observed number of animals captured per 100 trap-nights.

^b Exp.=Expected number of animals captured based on proportion of total area occupied by each habitat type and total observed captures.

The twelve species of medium-sized mammals observed were beaver, muskrat, porcupine, nuttall's cottontail, snowshoe hare, white-tailed jackrabbit, raccoon, long-tailed weasel, mink, striped skunk, and coyote. bobcat tracks were seen on river banks.

Raptors (Birds of Prey)

Thirteen raptorial species were observed in addition to the peregrine falcon and bald eagle (see Threatened and Endangered Species). The most common year-round resident sighted was the golden eagle. Most observations were in stony grasslands and on rocky cliffs. An active eagle nest was located near Stillwater Mining Company's headquarters. During 1980, a single fledgling was produced. The nest has apparently not been active since (Les Darling, Stillwater Mining Company, pers. com., September 14, 1984).

The northern harrier, red-tailed hawk, and American kestrel are common summer residents of the study area. Rough-legged hawks are the most common winter resident; prairie falcons are also present.

Songbirds

Ninety-two species of songbirds were observed during the one-year study period (1980-81). Riparian woodlands and open Douglas-fir forest supported both a large number of species and total birds. Stony grasslands were used by few species, although western meadowlarks, vesper sparrows, and mourning doves were occasionally numerous.

Gamebirds and Waterfowl

Fifty-one observations of blue grouse were made during baseline inventories. Most blue grouse were sighted in open forested habitats. The steep, forested slopes west of the proposed mine accounted for several observations. Ruffed grouse were observed on 27 occasions. Most were sighted in ravine aspen or riparian woodland habitats. Gray partridge are present, but uncommon, in the study area. Their habitat is suboptimal due to insufficient amounts of cultivated lands.

Even during spring and fall migration periods, waterfowl use of the study area is limited. Scattered observations were made on the Stillwater River or stock ponds. Mallards were the most abundant species.

Reptiles and Amphibians

Red-sided garter snakes, wandering garter snakes, yellow-bellied racers, prairie rattlesnakes, and bullsnakes, although uncommonly observed, used a variety of habitats. One Rocky Mountain rubber boa was observed. Six observations of leopard frogs, all near water, were made.

THREATENED AND ENDANGERED SPECIES

Plant Species

One forb species found in the study area, mountain ladyslipper (Cypripedium montanum), is included on the proposed list of threatened or endangered plant species published by the U.S. Fish and Wildlife Service. Mountain ladyslipper is listed as a category 2 plant, defined as a species "for which information now in the possession of the service indicates the probable appropriateness of listing as endangered or threatened, but for which sufficient information is not presently available to biologically support a proposed rule. Further biological research and field study will usually be necessary to determine the status of the taxa included in this category." This species was not found in the proposed permit area.

Animal Species

Peregrine falcons are known to have nested within the study area. One cliff complex in particular is identified as the most suitable nest site of the

study area (USFS, 1984). The cliff complex was occupied in 1975-76, with an unconfirmed sighting reported as late as 1980. An immature bird was seen during the 1980-81 survey period, but no active pairs were found. There appears to be additional nesting habitat available downstream from the study area.

The riparian and mosaic habitats close to the cliff and along the length of the river provide excellent hunting habitat for peregrines. Nongame bird transects have documented the presence of preferred prey items.

Bald eagles are present in the study area during fall and early winter (October-December) and winter/spring periods (February-March). This seasonal use appears to occur regularly, although mid-winter use is probably low and sporadic. Riparian woodland and open habitats within the study area are important for feeding, roosting, and perching. There is no documented nesting of bald eagles in the Stillwater River drainage, although suitable habitat exists in the study area. The number of bald eagles using the area varies. Between August and December 1980 twelve bald eagles were observed in the study area. In 1981, as many as seven bald eagles were observed at one time using the cottonwood woodlands along the Stillwater River.

CLIMATE

The region containing the project area has a mountainous continental climate, owing to its location in the mountains far from large bodies of water. This type of climate is characterized by large daily and annual temperature ranges and marked differences in precipitation, temperature, and wind patterns over distances of only a few miles.

Thirty-year climatological normals are not available for the immediate area. The data presented in figure III-14 are from Red Lodge, located 35 miles southeast of the minesite.

Precipitation

Average annual precipitation is 23.2 inches. Over 53 percent of this falls during March through June. About 3.5 inches fall monthly during April, May, and June. However, the greatest amount of effective precipitation--water available for soil formation and erosion--falls during March and April (fig. III-14). The percentage of total precipitation occurring as snow increases with elevation. Below 5,000 feet snow accounts for 15 to 20 percent of the total, while above 9,000 feet snow sometimes accounts for as much as 90 percent.

Severe weather in the Stillwater River Valley is uncommon. Heavy thunderstorms occasionally take place in July and August and less frequently in June and September. There is a 20 percent chance a one-inch rainfall will occur in one hour in any given year, whereas a three-inch total in 24 hours could be expected one year in ten (table III-10). Hailstorms also occur infrequently.

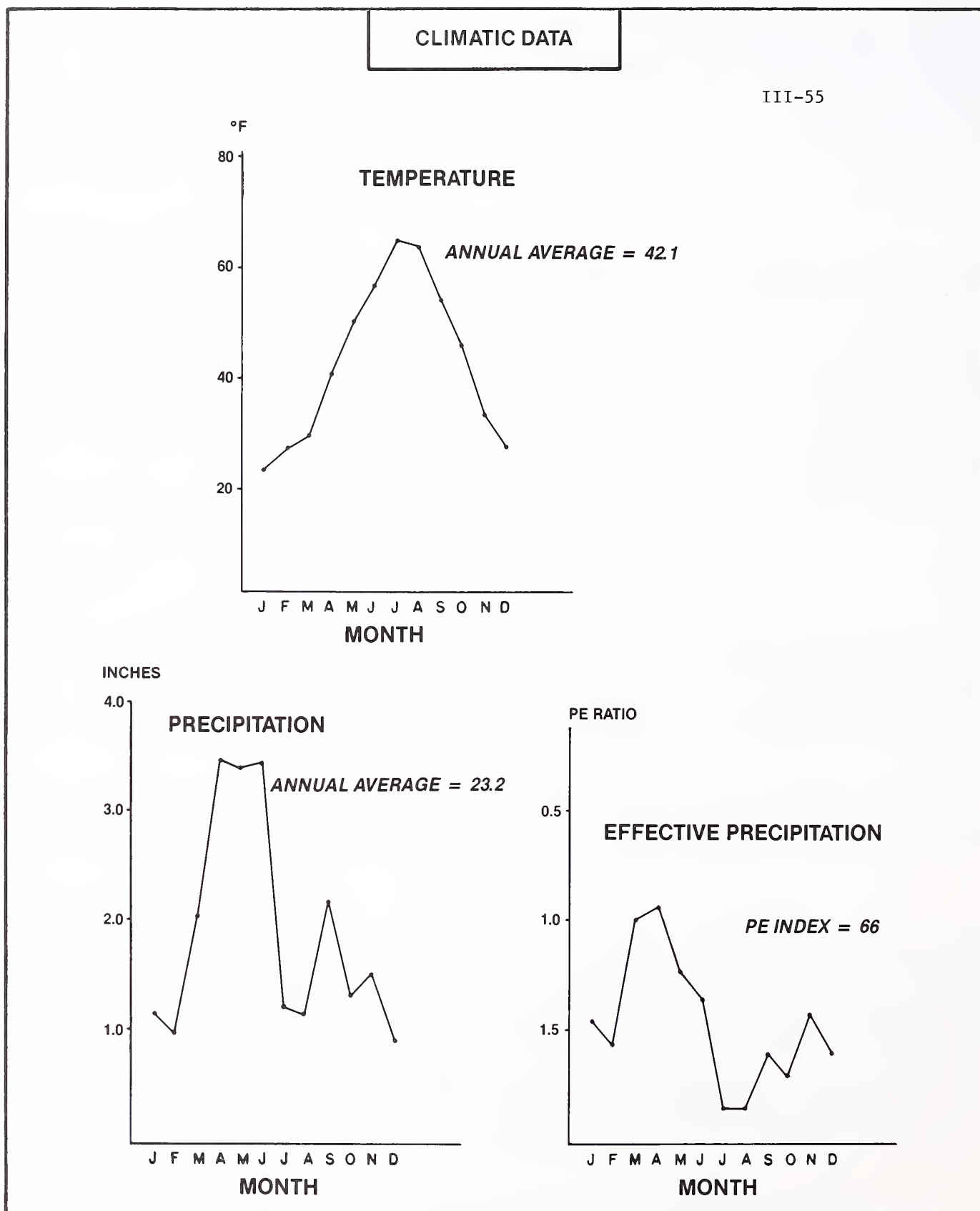


FIGURE III-14

Data from Red Lodge, Montana, from 1931 to 1960 show that temperature, precipitation and effective precipitation vary sharply with the season. Precipitation is heaviest in April, May, and June. January is the coldest month, July the hottest.

TABLE III-10

Size of Largest Storm that can be
Expected at the Project Area During Various
Lengths of Time

Length of Event	Interval in Years					
	2	5	10	25	50	100
	Size of Largest Storm (Inches)					
1 hour	0.7	1.0	1.2	1.5	1.7	1.9
6 hours	1.2	1.6	1.8	2.2	2.4	2.8
24 hours	2.0	2.8	3.0	3.4	3.8	4.2

Source: Miller et al., 1973.

Temperature

The annual average temperature is about 42°F and decreases with increasing elevation. At 10,000 feet, the average is estimated to be about 30°F. The warmest months are July and August and the coldest is January. At lower elevations the first freezing temperature in autumn normally occurs in mid-September and the last occurs in mid-June. At elevations above 7,500 feet, freezing temperatures may occur at any time.

Winds

Wind speed and direction were measured at the minesite and the Hertzler Ranch site from September 1, 1980, through August 31, 1981. Prevailing winds are from the southwest to the northwest throughout the year. The average wind speed was 10 miles per hour (mph) at the minesite and 7.4 mph at the Hertzler Ranch site. Only during August was the month's average wind speed lower at the minesite than at the Hertzler Ranch site. Maximum hourly wind speeds were usually greater at the minesite (figs. III-15 and III-16). During January 11-12, 1981, the wind speed at the minesite exceeded 29 mph for 29 consecutive hours.

AIR QUALITY

The air quality at the Stillwater Project area is excellent. For the monitoring period of August 1980 through July 1981, annual average total suspended particulate (TSP) concentrations were $9.6 \mu\text{g}/\text{m}^3$ (micrograms per cubic meter) at the Beartooth Ranch site, $14.0 \mu\text{g}/\text{m}^3$ at the minesite and $17.6 \mu\text{g}/\text{m}^3$ at the Hertzler Ranch site. The maximum 24-hour TSP concentrations, recorded in August 1981, were $343 \mu\text{g}/\text{m}^3$ at the Beartooth Ranch site, $41 \mu\text{g}/\text{m}^3$ at the mine-site, and $89 \mu\text{g}/\text{m}^3$ at the Hertzler site. These concentrations are well below

FIGURE III-15

The average wind speed at the Hertzler site is about 7 miles per hour. Winds from the southwest to northwest prevail.

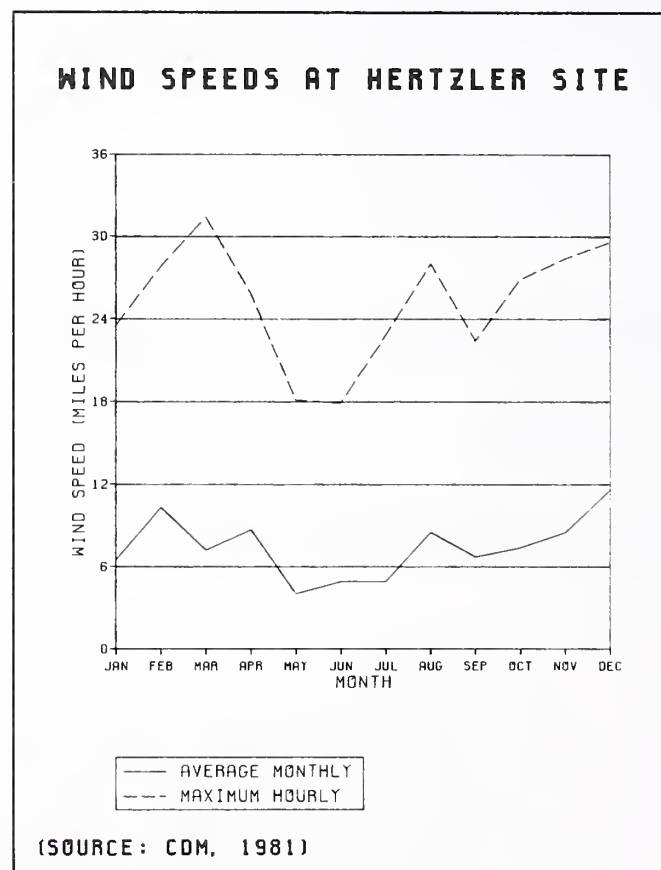
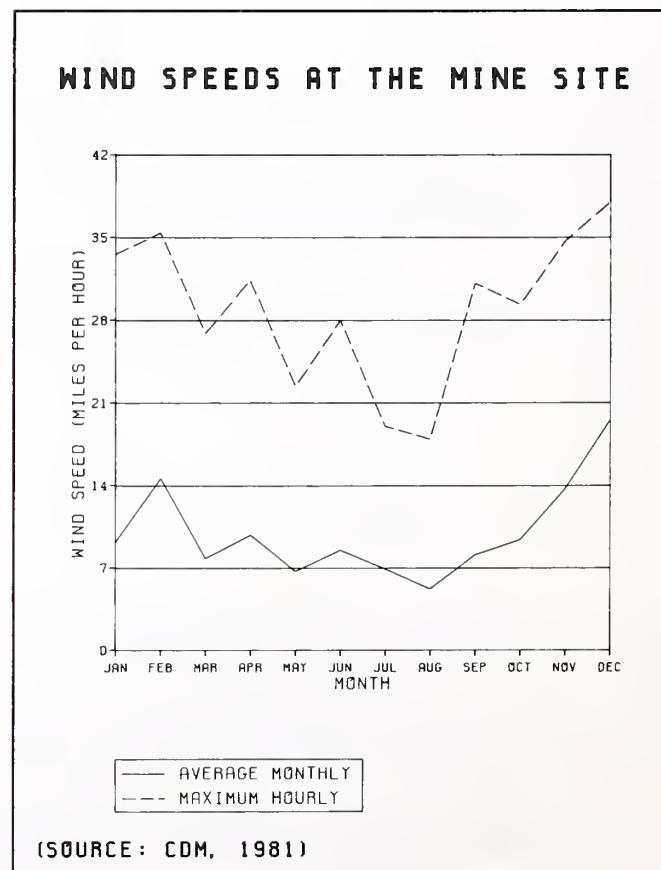


FIGURE III-16

Wind speeds at the minesite, averaging about 10 miles per hour, are slightly higher than at the Hertzler site. Hourly maximum speeds occasionally exceed 35 miles per hour.



both federal and Montana ambient air quality standards (table III-11). Sulfate and lead concentrations measured at the minesite were also low: Lead concentrations averaged $0.002 \mu\text{g}/\text{m}^3$; sulfate concentrations averaged $2.2 \mu\text{g}/\text{m}^3$.

The major sources of TSP in the area are probably vehicle traffic and wind erosion. Thus, during the winter when road surfaces are frozen and disturbed areas are snow covered, the TSP concentrations are lowest (fig. III-17). The entire area is classified as a Class II airshed, including the Absaroka-Beartooth Wilderness.

There are no major pollution sources in the area, so all other pollutants are present in only very low concentrations.

EMPLOYMENT AND INCOME

Employment

Despite the 9-percent decline in employment during the 1970s (table III-12), a loss of 63 basic industry jobs, agriculture remained the leading employer in Stillwater County. An increase in manufacturing employment of 50 jobs partially made up for the decline in basic industry employment. Led by increases in the derivative sector industries of trade, services, and nonfarm proprietors, total employment in the county rose from 1,782 jobs to 2,107 jobs, an average annual rate of 1.9 percent. The increase during the 1970s was a reversal of the trend of the preceding 20 years.

Fifty-three percent of county heads of households are employed, 2 percent are unemployed, and the remaining 45 percent are retired or are housewives (Entercom, 1981, p. 829). Unemployment in the county has generally run at a rate significantly below the statewide rate from 1970 to 1981 (table III-13). However, in recent years the county unemployment rate has risen to a level equal to and above the state unemployment rate. As of March 1984 the county unemployment rate was 13.1 percent, compared to the statewide average of 9.7 percent (Montana Department of Labor and Industry, 1st Quarter 1984, p. 11).

Because of the increasing number of county residents who commute to jobs outside the county, the number of employed persons grew at a rate faster than the rate of employment growth, particularly during the second half of the 1970s. From 1970 to 1979, the number of employed persons increased from 1,699 to 2,188 (table III-13), or at an average annual rate of 2.5 percent. The growth rate was higher from 1975 to 1979, increasing at an average annual rate of 4.3 percent, compared to the 1.6 percent rate from 1970 to 1975. In recent years, the number of employed persons has decreased from a high of 2,497 in 1980 to 1,945 in 1982. Such a decline represents an annual average rate of 7.9 percent.

Twenty-three percent of the persons employed in Stillwater County commute to jobs outside the county (Entercom, 1981, p. 916); another 11 percent work

TABLE III-11

Ambient Air Quality Standards (AAQS)

Pollutant	Averaging Time	Montana	Primary ^a	Secondary ^b
Total Suspended Particulate	Annual 24 Hour	75 $\mu\text{g}/\text{m}^3$ ^b 200 $\mu\text{g}/\text{m}^3$ ^f	75 $\mu\text{g}/\text{m}^3$ ³ 260 $\mu\text{g}/\text{m}^3$	60 $\mu\text{g}/\text{m}^3$ ³ 150 $\mu\text{g}/\text{m}^3$
Sulfur Dioxide	1 Hour 3 Hour 24 Hour Annual	0.50ppm ^e --- 0.10ppm ^d 0.02ppm ^f	---h --- 0.14ppm ^f 0.03ppm ^f	--- 0.5ppm --- ---
Carbon Monoxide	1 Hour 8 Hour	23ppm ⁴ 9ppm ⁴	35ppm 9ppm	35ppm 9ppm
Lead	90 Days	1.5 $\mu\text{g}/\text{m}^3$ ^f	1.5 $\mu\text{g}/\text{m}^3$	1.5 $\mu\text{g}/\text{m}^3$
Nitrogen Dioxide	1 Hour Annual	0.30ppm ^d 0.05ppm ^f	0.05ppm ^f	0.05ppm ^f
Settled Particulate	30 Days	10g/m ² ^f	---	---
Nonmethane Hydrocarbons ^g	3 Hour (6-9 a.m.)	---	0.24ppm	0.24ppm
Photochemical Oxidants (ozone)	1 Hour	0.10ppm ^d	0.12ppm	0.12ppm

^aFederal ambient air quality standards with averaging time less than 1 year are not to be exceeded more than once per year.

^bArithmetic average; not to be exceeded.

^cGeometric mean; not to be exceeded.

^dNot to be exceeded more than once per year.

^eNot to be exceeded more than 18 times in any 12 consecutive months.

^fNot to be exceeded.

^gSet as a guide to achieve photochemical oxidant standards.

^h---indicates no standard.

both inside and outside the county. Intercounty commuters earned higher salaries than persons employed only inside the county: The 26 percent of the residents who worked in jobs outside the county earned more than \$24,000 in 1980; 13 percent of the residents who worked only inside the county (Entercom, 1981, p. 940) earned that much. The intercounty commuters have not had as

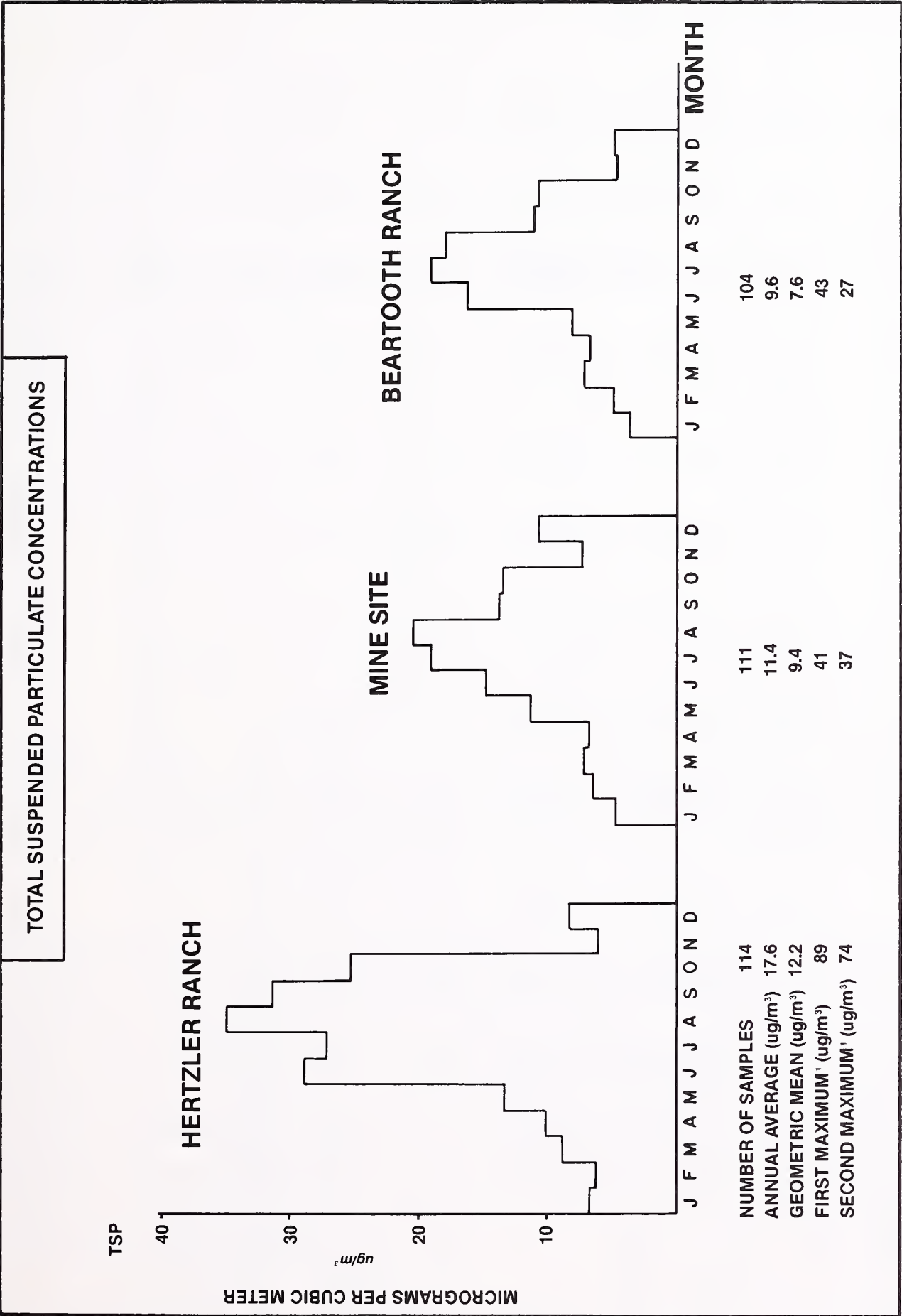


FIGURE III-17

Air quality at all three monitoring sites---Hertzler Ranch, the minesite, and Beartooth Ranch---is excellent. Total suspended particulate concentrations are well below both state and federal limits.

TABLE III-12

Employment by Major Industry in
Stillwater County
1970-79

	1970 ^a	1971 ^a	1972 ^a	1973 ^a	1974 ^a	1975 ^a	1976 ^a	1977 ^a	1978 ^a	1979 ^a	1980	1981	1982
Agriculture ¹	677	689	693	688	710	677	602	601	604	634	625	625	636
Mining	(D)	(D)	(L)	(D)	(D)	(D)	(L)	(L)	(L)	(D)	(D)	(D)	(D)
Construction	23	29	31	32	31	21	36	50	56	50	55	81	46
Manufacturing	64	77	90	114	123	133	115	99	107	114	108	133	130
T.U. ²	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	79	81	70	73
Trade	178	201	195	206	206	195	214	220	236	266	279	263	266
F.I.R.E. ³	38	40	45	45	45	42	39	44	47	55	55	54	53
Services	(D)	(D)	(D)	126	142	152	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Nonfarm													
proprietors	261	229	246	270	294	297	307	345	375	371	384	391	402
Federal													
government	71	71	75	66	71	69	67	60	63	63	64	55	54
State and Local													
government	217	226	231	233	243	251	253	257	266	268	264	257	265
TOTAL	1,722	1,789	1,850	1,875	1,972	1,952	1,971	1,995	2,076	2,172	2,211	2,220	2,170

Sources: U.S. Department of Commerce, 1980a, 1981a.

^aEstimated based on 1967 Standard Industrial Codes.^bEstimates based on 1972 Standard Industrial Codes.¹Includes: farm proprietors, farm wage and salary employment, agricultural services, forestry, fisheries and other.²Transportation and public utilities.³Finance, insurance and real estate.(D) Not shown to avoid disclosure of confidential data. Data are included in totals.
(L) Less than 10 wage and salary jobs.

TABLE III-13

Stillwater County Employment Statistics
1970-1983

Year	Labor Force	Employment	Unemployment Number	County Rate	Montana Unemployment Rate
1970	1,766	1,699	67	3.8	4.3
1971	1,838	1,733	105	5.7	4.8
1972	1,757	1,673	84	4.8	4.8
1973	1,774	1,699	75	4.2	4.8
1974	1,884	1,815	69	3.7	5.2
1975	1,938	1,843	95	4.9	6.4
1976	2,016	1,920	96	4.8	6.1
1977	1,968	1,864	104	5.3	6.4
1978	2,111	2,019	92	4.4	6.0
1979	2,263	2,188	75	3.3	5.1
1980	2,581	2,497	84	3.3	6.0
1981	2,335	2,241	94	4.0	6.9
1982	2,407	2,201	206	8.6	8.6
1983	2,188	1,945	243	11.1	8.8

Source: Montana Department of Labor and Industry Quarterly Report, 1st Quarter, 1984.

Note: Employment as used here is the number of employed persons by place of residence. This number is different from the Department of Commerce employment figure, which measures the number of jobs by place of work.

great an effect on the local economy as might be indicated by their greater-than-average earnings, because the members of their households are less likely to shop in Stillwater County than are other county residents. Eighty-one percent of the residents employed inside the county, compared to 39 percent of those employed outside the county, usually shop for everyday items in Stillwater County (Entercom, 1981, p. 582). Most residents in the county shop for major purchases outside the county, but persons working outside the county are even less likely to shop in Stillwater County: 26 percent of those working in the county compared to 8 percent of those outside shop in Columbus (Entercom, 1981, p. 586). Besides having greater opportunity to shop outside the county, intercounty commuters live closer to Billings and so are more likely to shop outside the county. Sixty-two percent of the intercounty commuters live near Park City, 23 percent near Columbus, and 13 percent live near Absarokee (Entercom, 1981, p. 913).

III-64 / Employment and Income

Income

The increasing trend for county residents to hold jobs outside the county is reflected in county personal income statistics. One of the items in the total personal income estimate made by the U.S. Department of Commerce is the "residence adjustment" (table III-14). This item reflects flows of earned income into the county because of intercounty commuters. During the 1970-74 period, only 7 percent of the growth in Stillwater County total personal income was provided by growth in the residence adjustment (U.S. Department of Commerce, 1980b), compared to 34 percent of the 1974-79 growth (U.S. Department of Commerce, 1981b).

Income growth in the county during the 1970s was led by increases in transfer payments, dividends, interest and rent, which provided 57 percent of the growth. These items, which reflect the importance of retired persons to the local economy, made up 43 percent of county total personal income in 1979 (table III-14). Net labor and proprietor's income has been adversely affected by poor earnings in the farm industry in recent years, but still managed to provide 9 percent of income growth during the decade and stood at 42 percent of the total in 1979.

SOCIOLOGY

The Study Area

The sociology study area includes all of Stillwater County (fig. S-1). The southern portion of the county includes 187,850 acres of the Custer National Forest. Columbus is the only incorporated town in the county.

Stillwater County is rural in character; agriculture has been the foundation of the local economy since the area was settled. The largest percentage of workers (28 percent) are employed in farming and ranching (Entercom, 1981). Although the Entercom study included forestry and fishing in the farming category, few county residents are employed in forestry or fishing operations (Mitch Press, Stillwater County Planner, oral com., March 1982).

Previous mineral development and exploration brought a peak population of 1,900 in 1943 to the Nye area for less than three months. The highest number of people employed recently in mineral activity was 41 in the summer of 1981 during the engineering phase of the Anaconda Minerals Company project. The only other energy or mineral development in the county is a minor amount of oil and gas production.

The metropolitan area nearest to Stillwater County is Billings, 41 miles east of Columbus. Seventy-five percent of county residents shop for major items in Billings and 23 percent work outside Stillwater County, most probably in Billings. Columbus is the county trade center: 37 percent of county residents purchase everyday items such as groceries at Columbus; 17 percent also purchase major items, such as cars, furniture and household appliances. Other towns in the county, Absarokee, Fishtail, Beehive, Nye, and Dean, offer

TABLE III-14

Stillwater County Personal Income by Major Source, 1970-83
(thousands of dollars)

ITEM	1970 ¹	1972 ¹	1973 ¹	1974 ¹	1975 ²	1976 ²	1977 ²	1978 ²	1979 ²	1980 ²	1981 ²	1982 ²
TOTAL LABOR AND PROPRIETOR'S INCOME BY PLACE OF WORK ³												
By type												
Wage and salary disbursements	5,969	6,741	7,810	8,429	9,125	9,620	10,386	12,503	15,541	16,684	16,348	
Other labor income ⁴	305	357	441	543	636	748	747	887	1,081	1,147	1,245	
Proprietor's Income	8,569	8,419	8,195	7,261	2,557	2,162	3,857	2,749	1,766	1,968	865	
Farm ⁴	7,270	7,002	6,706	5,553	797	78	1,607	564	-90	303	-762	
Nonfarm	1,299	1,417	1,489	1,708	1,760	2,084	2,250	2,185	1,856	1,665	1,627	
By industry												
Farm	8,366	8,339	8,323	7,038	2,165	1,492	3,095	2,438	2,683	2,934	2,286	
Nonfarm	6,477	7,178	8,123	9,195	10,153	11,038	11,895	13,701	15,705	16,865	16,172	
Private	4,912	5,470	6,221	7,016	7,765	8,418	9,036	10,549	12,245	13,121	12,126	
Government	1,565	1,708	1,902	2,179	2,388	2,620	2,859	3,152	3,460	3,744	4,046	
DERIVATION OF PERSONAL INCOME BY PLACE OF RESIDENCE												
Total labor and proprietor's income	14,843	15,517	16,446	16,233	12,318	12,530	14,990	16,139	18,388	19,799	18,458	
by place of work												
Less: personal contributions for												
social insurance by place of work	427	518	569	643	730	804	874	1,043	1,155	1,345	1,348	
Net labor and proprietor's income												
by place of work	14,416	14,999	15,877	15,590	11,588	11,726	14,116	15,096	17,233	18,454	17,110	
Plus: residence adjustment	1,055	1,182	1,350	1,487	1,702	3,511	5,147	5,821	6,123	6,895	7,532	
Net labor and proprietor's income												
by place of residence	15,471	16,181	17,227	17,077	13,290	15,237	19,263	20,917	23,356	25,349	24,642	
Plus: dividends, interest, and rent ⁵	4,131	4,719	5,898	6,081	6,736	7,329	8,621	10,244	12,563	16,021	17,160	
Plus: transfer payments	2,296	2,682	3,163	3,720	4,205	4,722	5,163	5,871	6,900	8,193	9,672	
Personal income by place of residence	21,898	23,582	26,288	26,878	24,231	27,288	33,047	37,032	42,819	49,563	51,474	

Sources: U.S. Department of Commerce, 1980b, 1981b.

¹Estimates based on 1967 Standard Industrial Codes.²Estimates based on 1972 Standard Industrial Codes.³Consists of wage and salary disbursements, other labor income and proprietor's income. Primary source for private nonfarm wages: FR⁴202 covered wages, Montana Employment Security Commission.⁵Includes the capital consumption adjustment for nonfarm proprietors.⁶Includes the capital consumption adjustment for rental income of persons.

limited shopping. Park City serves as a bedroom community for Billings commuters: 60 percent of the residents in the Park City census division work outside the county (Entercom, 1981, p. 913).

The proximity of the study area to the Billings metropolitan area has resulted in an increase in Stillwater County of (1) part-time residents who have built or purchased second homes for recreational purposes or for retirement; (2) through traffic by city residents on their way to Custer National Forest or the Absaroka-Beartooth Wilderness; and (3) suburban development in the communities closest to Billings (Camp Dresser and McKee [CDM], May 1981, p. 2.10-86).

Methodology

A survey was conducted in 1981 by Entercom, a research firm, to gain information on the employment, recreational activities, attitudes, and demographic characteristics of Stillwater County residents. Three hundred eighty-two interviews were completed from a total of 3,139 households in the county. Households were selected using a systematic random sample that gave each household an equal chance of being selected. The adult in each household selected for an interview was also chosen by a method that gave each adult in the household an equal opportunity of being selected. Except where noted, the data in the remainder of this section come from the Entercom survey. The results of this survey are statistically accurate to within 5 percent at a 95 percent confidence level. Simply stated, if a sample of households were selected 100 times, 95 times out of the 100 the result obtained would not vary more than 5 percent from the results that would be obtained if all households in the county were interviewed (Entercom, 1981).

The Entercom survey was conducted as part of the background information for the proposed Anaconda Minerals Company project. Increased levels of unemployment in Stillwater County may have since affected some residents' attitudes.

Demography

The county has no distinctive ethnic or cultural characteristics. Ninety-nine percent of 1980 county residents were white (U.S. Dept. of Commerce, 1981d).

The 1980 county population was 5,598, up 21 percent over the 1970 figure (U.S. Department of Commerce, 1981c), following a downward trend since 1920 (Montana Department of Community Affairs, 1975). Much of the recent growth has occurred in or near Park City, which has experienced a 49 percent growth in population.

The county has a high proportion of people 65 years and older--31 percent of the residents. Another 16 percent are between 55 and 64. The age categories 18 to 34 and 35 to 54 each accounted for 26 percent of the residents. In Absarokee, 60 percent of the households had members over 64; another 13 percent had members between 55 and 64.

Seventy-one percent of those surveyed are married and 16 percent are widowed. The average size of the households was 2.6. The largest proportion of households, 38 percent, have two people. Twenty-seven percent have four or more persons; 20 percent are single-person households; and 15 percent are three-person households.

The largest proportion of residents, 19 percent, earned between \$16,000 and \$24,000 in 1980. Of the remaining residents, 11 percent earned between \$24,000 and \$32,000; 10 percent earned between \$4,000 and \$8,000; 8 percent between \$32,000 and \$40,000; 8 percent less than \$4,000; and 6 percent over \$40,000. The remaining 15 percent did not respond. Twenty-three percent of employed persons work outside the county and 11 percent work both in Stillwater County and outside.

Twenty percent of those surveyed had attended some college; another 13 percent graduated from college, and 6 percent (about half of all college graduates) did postgraduate work. The largest proportion, 41 percent, were high school graduates. Twenty-six percent had not completed high school.

Thirty-five percent of the 1981 county population surveyed moved to the county within the last 10 years. By census divisions, this influx was true of 55 percent of Park City residents, 40 percent of the Columbus division residents, 29 percent of the Columbus town division residents, 32 percent of the Absarokee division residents, and 18 percent of the Stillwater north division residents.

Occupational Structure

Of the employed residents, 30 percent work in technical, clerical, sales, administrative or support occupations; 25 percent in farming, forestry, or fishing; 13 percent in managerial or professional specialty occupations; 12 percent in operations, manufacturing, or labor; 11 percent in precision production, craft or repair occupations; and 10 percent in service occupations.

Forty-eight percent of those employed work for a private company, business, or individual. Twenty-seven percent are self-employed in business, professional practice, or ranching. Twenty-five percent work for government agencies or other organizations.

Values

According to Gold (1976), the people in Stillwater County generally value their current lifestyle because it is simple, is not stressful, and gives them a sense of permanence.

Current Stillwater County residents chose to live there, according to those surveyed, for a number of reasons: 17 percent cited a farm, a ranch, a cabin, land or a business; 13 percent cited the desire to be near relatives; 11 percent stated the desire to be in a small community with peace and quiet; 11 percent noted job opportunities; and 10 percent liked the beauty of the area. Additional reasons were given by less than 10 percent of the respondents.

Twenty-eight percent of residents surveyed stated that they must have either their family, a good relationship with their family, their family nearby, or be able to raise a good family to ensure a happy and satisfying life. Other attributes of a happy life mentioned were good health (listed by 16 percent of those surveyed); adequate income (listed by 20 percent); a good job (listed by 14 percent); friends (listed by 10 percent); and recreation or a hobby (listed by 10 percent). Other needs were listed by fewer than 10 percent of those surveyed.

Eighty-four percent of the households own their home or are purchasing it. Such levels of home ownership indicate a commitment to the area by a large majority of the households.

Attitudes and Concerns

Residents surveyed feel they now can have effective involvement in matters affecting their community; however, they are split as to whether or not there are adequate controls to ensure that individual interests are protected when in conflict with those of large corporations.

Directly relevant to the mine development issue are residents' perceptions of regulatory control of mining and reclamation efforts. While most residents feel that effective control is possible, a substantial minority (28 percent) do not.

Eight percent of the survey respondents said they had heard or read something about a proposed mining operation in the county. In Absarokee, 91 percent were aware of the proposed mine, while in the northern portion of the county only 55 percent were aware of it.

Three primary advantages to development of the Anaconda project (and presumably to the Stillwater Mining Company project) were seen by the residents surveyed: (1) job opportunities, mentioned by almost two thirds; (2) a boost to the area's economy, mentioned by nearly half; and (3) a broader tax base for the county, mentioned by 29 percent. Other advantages mentioned by 10 percent or fewer individuals included population growth, better school system, better roads, development of domestic rather than importing foreign minerals, and improvement of the housing industry. Four percent did not see any advantages to the residents of Stillwater County.

Despite these advantages, those surveyed listed more disadvantages. Three themes underlay the nine most mentioned disadvantages. The first theme, population influx, was mentioned by 30 percent of the respondents as the main disadvantage. The residents fear that development would bring too many people into the area too quickly and that many of the in-migrants would be transient or undesirable, thereby increasing crime. Many residents felt there would be rapid social change and social problems.

The second theme, overburdening of the county public service system, was mentioned by 29 percent as the main disadvantage of the project. Of specific concern were the burdens on schools, roads, law enforcement, water supply and

sewer systems, medical care, and fire protection. The third theme, environmental problems which could be caused by development, including air, water and noise pollution, loss of wilderness, loss of wildlife, and scarring of the land, was mentioned by 20 percent as the main disadvantage.

Other concerns mentioned, but by fewer than 10 percent were additional tax burdens on county residents following the population decline after mining; hardship for ranchers; increased living costs; and creation of a boom town. Eight percent felt there would be no disadvantages to county residents.

The residents surveyed clearly believed that job opportunities, local economic stability, and, to a lesser extent, shopping facilities, medical and mental health facilities, and cultural opportunities would be improved by development of the project. The residents also clearly felt that air, water and scenic quality, housing costs and availability, ranching and farming, and friendliness and concern of neighbors would be adversely affected.

COMMUNITY SERVICES

The part of Montana most likely to be affected by the Stillwater Project, and therefore the area analyzed here, is Stillwater County. The demand on future services projected below would occur even without the addition of the proposed project.

Schools

Columbus

The 1984 Columbus elementary school enrollment was 295 (Stillwater Mining Company, 1984b, p. 46). Sixteen classrooms and 18 teachers serve kindergarten through eighth grade providing one classroom per 18 students and one teacher per 16.5 students. Elementary school enrollment is projected to increase from 6 to 10 students per year without the Stillwater Project (Stillwater Mining Company, 1984b, p. 46). Future Columbus elementary school enrollment could surpass Montana school accreditation standards, depending on the age distribution of students. The Columbus elementary school needs expansion; a bond issue was approved but not sold (Briscoe, Maphis, Murray, Lamont, Inc. [BMML], 1981).

The 1984 enrollment for Columbus High School was 150 students (Stillwater Mining Company, 1984b, p. 52). The school has 13 teachers and 13 classrooms for an average of one each per 11 students. Baseline enrollment will increase approximately 3 to 5 students annually over the next 5 to 6 years (Stillwater Mining Company, 1984b, p. 52).

III-70 / Community Services

Absarokee

Enrollment in the Absarokee elementary school was 188 students in 1984 (Stillwater Mining Company, 1984b, p. 33). Approximately 30 of these students are from the Nye and Fishtail school districts. The elementary school has 12 teachers, 10 classrooms, and 2 instructional aides. There are 16.2 students per teacher which allows some additional capacity under accepted Montana accreditation standards, depending on the age distribution of incoming students. However, because of the uneven distribution among grades, some classrooms are at capacity now (Stillwater Mining Company, 1984b, p. 33).

Absarokee high school shares some facilities and personnel, including a principal and superintendent, with the elementary school. The high school has an enrollment of 97 students and has a teaching staff of nine for an average of 11 students per teacher. The school has eight classrooms (Stillwater Mining Company, 1984b, p. 40). The school has additional capacity.

Nye and Fishtail

The Nye elementary school enrollment has ranged from 8 to 17 students over the past six years (Stillwater Mining Company, 1984b, p. 57). The current enrollment is 8 students (Stillwater Mining Company, 1984b, p. 57). The school has one teacher and one classroom with capacity for additional students.

The Fishtail elementary school has an enrollment of five students. Enrollment has ranged from 8 to 22 students over the past six years (Stillwater Mining Company, 1984b, p. 59). With one teacher and 1 classroom the school has capacity for additional students.

Solid Waste

The County Greenbox Program has over 40 disposal sites that serve the unincorporated portions of the county. The program is currently near capacity. The county disposes of waste at the Livingston incinerator and the Billings landfill, a site adequate for the foreseeable future. The county has one 32-yard, one 75-yard, and one backup trash compactor. The county plans to place another compactor on a truck recently purchased. The town of Columbus has a collection system that feeds into the county transfer site for disposal. Absarokee has a private collection system that feeds into the greenboxes for disposal (BMML, 1981).

Law Enforcement

The Stillwater County Sheriff's Department provides law enforcement for the unincorporated portions of Stillwater County. It handles dispatch service for the Columbus Fire Department, the Columbus Rural Fire District, Columbus Police Department, and the Columbus ambulance, as well as for law enforcement.

The department has the equivalent of 7 full-time sworn officers. Complaints in the Absarokee/South County district are generating a need for an additional deputy in that area; three full-time deputies are located in Columbus and two in Absarokee. The county jail has an overnight capacity of four persons. A new jail is needed, although Yellowstone County plans to construct a new jail and has indicated a desire to share that facility with neighboring counties.

Columbus City Police

The Columbus city police department has three officers and one vehicle. The department is housed in the city hall. Office space is limited but adequate for three persons (Ted Mrozek, Chief of Police, oral com., December 19, 1984). The Columbus police department shares the jail facility with the sheriff's department.

Water Supply

The city of Columbus water system serves the residents of Columbus and a limited area outside the city limits. The city has a virtually unlimited supply of water from the Yellowstone River. Average use is greater than 600,000 gallons per day. Summer use peaks at an additional 200,000 gallons per day. The system is capable of serving 1,600 to 1,700 people, which is about 100 to 200 additional persons. However, the system does have inadequacies and limitations, including a substandard water main trunk crossing the Yellowstone River, an undersized main connecting the water storage tank to the northern service areas, and some inadequately sized and looped portions of the water distribution system (Kerin and Associates, 1984). The total cost of water system improvement is estimated to be \$244,750.

The Absarokee Water Users Association system serves the Absarokee town area. The system meets all state water quality standards, and could accommodate 10 to 50 new residences; however, a new well may be needed for winter supply, and some system pipes now leak. The association has an unlimited water right (BMML, 1981).

Although system capacity is adequate, the distribution system, which is suspected of leakage, loses about 125,000 gpd during winter months (BMML, 1982, p. 9-42). Replacement of leaky distribution lines began in 1980 and it is estimated that 90 percent of the lines need repair (BMML, 1982, p. 9-43). The 1982 estimated repair cost is \$15,000 per 300 feet.

Sewer System

The Columbus sewer system provides service to residents in the city. The system uses two large and two small evaporation ponds. The city has no firm plans for expansion; however, the system is at capacity now. The sewage treatment ponds are at capacity now and solids build up in the sewage

III-72 / Community Services

collection system. The sewage collection lines and manholes and manhole steps are substandard (Kerin and Associates, 1984, pp. 2 and 46). The total cost to upgrade the existing sewage ponds and provide system expansion is \$506,575 (Kerin and Associates, 1984, pp. 21-22).

Rural Special Improvement District Nos. 5 and 7 operate as one district and service the residential area of Absarokee. The system consists of sewer lines and collectors and a 1.5-acre lagoon. The district needs another 7 acres of lagoon space to meet U.S. Environmental Protection Agency (EPA) standards. There is no room for expansion at the current site, but adequate space is available nearby. No funds have been identified to support the expansion. The system has a significant infiltration problem. The fecal coliform count is above EPA standards (BMML, 1981). The least expensive option for upgrading the system would demand \$198,000 for capital costs and \$15,000 to \$20,000 for operation and maintenance costs.

Fire Protection

The Stillwater County Rural Fire Department serves the portions of the county that are outside fire districts. The department also has mutual aid agreements with the fire districts. The department is equipped primarily to handle wildfires, for which the six volunteers are considered adequate. The department is generally unable to save burning structures because of the distance to most of the county from Columbus (Terry Nystel, Chief, Stillwater County Rural Fire Department, oral com., April 1982). As a result, the parts of the county outside the fire districts are not well protected against structural fires.

The Columbus Volunteer Fire Department serves the town of Columbus. The department has 20 volunteers. The district would like to acquire one additional minipumper (BMML, 1981). The department has a limited mutual aid agreement with the Absarokee Rural Fire District, under which the Columbus Department will respond to fires within the townsite of Absarokee.

The Absarokee Fire District covers the southern part of the county and responds to calls on the national forest. The district has 28 volunteers from Absarokee and 28 from Nye. The district has adequate equipment and manpower (Eugene Lukkes, Absarokee Fire District, oral com., March 1982).

The Columbus Rural Fire District, formed in December 1983, provides fire protection to the central portion of the county. The district has a fire truck, hand tools, and other equipment. The district did not budget for operation during 1984-85, however.

City Shop

The Columbus city shop maintains the city streets (which are in fair condition), the airport, cemetery, city parks, and city buildings, and operates the town solid waste collection system (Terry Johnson, oral com., March 1982).

Ambulance

A nonprofit corporation provides ambulance service to the town of Columbus, halfway to Absarokee, west to the county line, 12 miles toward Park City, and to all of the northern portion of the county. Twelve volunteers answer an average of five calls monthly. The number of volunteers is considered adequate. Eight of the volunteers are emergency medical technicians. Park City Ambulance serves the Park City area and 12 miles west toward Columbus. The Park City service has 7 volunteers, 3 of whom are emergency medical technicians (John Bartos, Stillwater Community Hospital Administrator, pers. com., March 6, 1985). The ambulance service is fully equipped, except for a tool to cut apart wrecked vehicles to free accident victims (BMML, 1981). The southern part of the county is served by the Absarokee Ambulance, which is operated by the same volunteers as the Absarokee Fire District. None of the volunteers are certified emergency medical technicians. No additional equipment is needed. The ambulance is funded privately and responds to an average of six calls a month (Eugene Lukkes, Chief, Absarokee Fire District, oral com., April 1982).

Hospital and Medical Personnel

The Stillwater Community Hospital primarily serves Stillwater County. Fifty-seven persons are employed at the hospital, including 4.5 full-time physicians, 7 consulting specialist physicians, 9 nurses, and 3 licensed practical nurses. The hospital has maintained a nearly constant 40 percent occupancy rate over the last 3 years. The hospital has 27 beds (John Bartos, Stillwater Community Hospital Administrator, pers. com., March 6, 1985). Some Stillwater County residents use Billings hospital facilities, particularly for special problems (BMML, 1981).

Three dentists and two optometrists also serve the county. This number is adequate (John Bartos, Stillwater Community Hospital, oral com., April 1980).

FISCAL CONDITIONS

Stillwater County

In Stillwater County, general fund revenues come primarily from property taxes (Briscoe, Maphis, Murray, and Lamont, Inc. [BMML], September, 1981, p. 2-32). Between 1978 and 1981 property taxes made up an average of 60 percent of total new general fund revenues. Federal payments in lieu of taxes (PILT) and state reimbursements, the second largest source, averaged 38 percent of the total. Fees, collection, licenses and permits made up the balance. During fiscal year 1983-84, property taxes raised about \$335,658 (44.4 percent) of total general fund revenues of \$755,537 (Montana Association of Counties, 1985).

III-74 / Fiscal Conditions

The major county funds--road, bridge, and poor fund--also received most of their revenue from property taxes.

The county reported expenditures of \$2,111,402 for fiscal year 1983-84. Of that amount 41.3 percent was for the general fund, 25.7 percent was for road fund, 9.1 percent for the bridge fund, 7.9 percent for the poor fund, and the remainder for other purposes (Montana Association of Counties, 1985).

Schools

The elementary school and high school in Absarokee rely almost equally on local property taxes and state equalization funds for revenue. During the 1983-84 school year, approximately 41.3 percent of the elementary district and 47.3 percent of the high school district budgets were funded through district and county levies. Meanwhile, equalization funds provided 45.1 and 41.98 percent of the elementary and high school budgets respectively. The schools in Columbus were slightly more dependent on state revenues: Local revenues made up 40.4 percent of the elementary school budget and 38.5 percent of the high school budget. State equalization funds provided 40.4 and 38.5 percent of the total elementary and high school budgets respectively (Steve Colberg, Statistician, Office of Public Instruction, oral com., January 9, 1985).

Tax Base

During the 1983-84 tax year, the county tax base, or taxable value, was made up of agricultural land, improvements, machinery and productions (37 percent); other land and improvement (18 percent); Montana Department of Revenue allocations of intercounty property (28 percent); personal property (10 percent); and the value associated with oil and gas production in the county (9 percent).

Inflation steadily eroded the county tax base during the 1970s. County taxable value declined by 25 percent (in real terms) over the decade. To keep up with inflation, the total average mill levy for state, county, and school purposes steadily increased throughout the decade. Between 1970 and 1980 the tax rate (mill levy) increased by 50 percent, rising from 128.19 mills to 192.61 mills. Despite the increase, the combination of a 25 percent decline in the real value of the tax base (in constant 1967 dollars) and a 20 percent increase in population resulted in a decline in real per capita receipts. In 1970 there was an average of about \$211 (1967 dollars) available for each county resident to provide basic county and educational services; in 1980 there was an average of only \$197 (in 1967 dollars) available.

LAND USE

Proposed Permit Area and Surroundings

The part of the permit area that contains the mine facilities (77 acres) is dominated by mining land uses (fig. III-18). The current mining area takes up

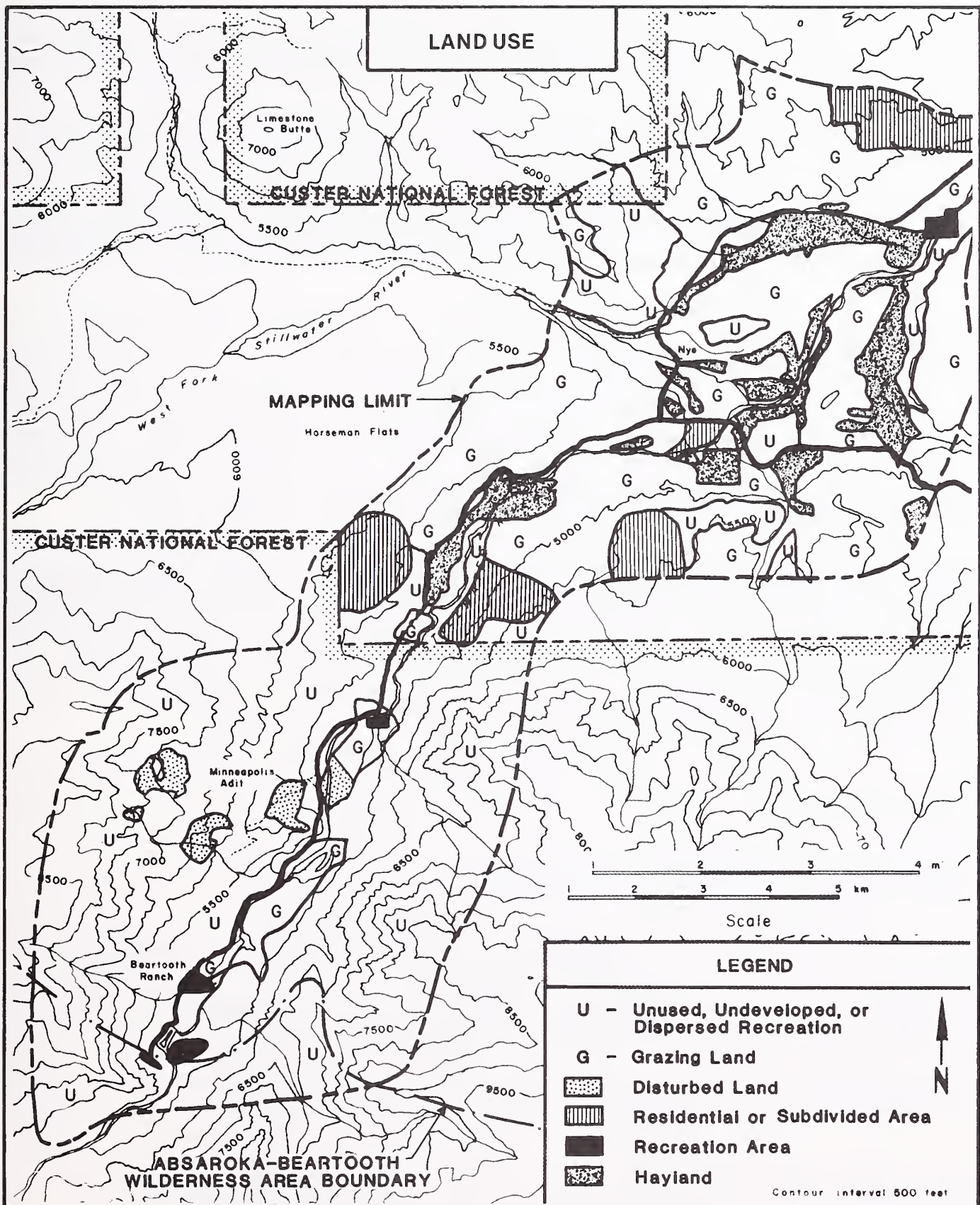


FIGURE III-18

Most of the land in and around the project area is undeveloped and used only for recreation and wildlife habitat. Most of the valley bottom is used for livestock grazing, although some lands are used for hay land and housing.

III-76 / Land Use

about 25 acres, and much of the balance is made up of land previously disturbed by mining. The proposed permit area is currently in low-good range condition and has a stocking rate of 22 to 74 cow-calf units for one month (table III-15).

The proposed permit area is located in the Stillwater River drainage in the southwest corner of Stillwater County. About 50 percent of the approximately 25,000 acres surrounding the area are undeveloped and used for dispersed recreation and wildlife habitat (Camp Dresser and McKee, [CDM]), 1981, p. 2.9-26). Agricultural use, largely livestock grazing, utilizes about 42 percent of the land of the area. Residential and recreational uses make up most of the balance.

Current and Previous Trends

No major changes in land uses or associated activities took place between 1900 and 1960 in the 25,000-acre study area around the proposed project. For this period, the Stillwater River Valley was primarily an agricultural area (CDM, 1981, p. 2.9-23); however, during World War II and the Korean conflict, U.S. price supports allowed the mining of chrome near the proposed mine.

Transitions in land uses began to occur in the late 1960s and early 1970s. The outdoor recreational potential of both public and private lands in the area attracted many people to the county and spurred the conversion of agricultural land to residential uses (CDM, 1981, p. 2.9-23). Between 1970 and 1980, about 7,000 acres of privately owned Stillwater County land were converted from agricultural to suburban tracts (Montana Department of Revenue, 1970, 1980). High interest rates and the 1974 subdivision legislation reduced the number of land sales in the county (CDM, 1981, p. 2.9-24).

TABLE III-15

Stocking Rates for Areas
That Would be Disturbed by Alternatives

Alternative Number	Recommended Stocking Rate		Potential Stocking Rate	
	1 Month	9 Months	1 Month	9 Months
1	22	2	22	2
2	72	8	86	10
3	48	5	56	6
4	65	7	98	11
5	74	8	104	12
6	57	6	80	9
Proposal	33	4	33	4

Range Condition and Stocking Rate

U.S. Soil Conservation Service (1981) methods were used to calculate range conditions and stocking rates for seven vegetation types (table III-15). The remaining vegetation types (12,070 acres) have not been designated as rangeland due to the disturbed nature of the land and the lack of forage. The average condition of the study area's rangeland is good, about 57 percent of climax vegetation. The recommended stocking rate is about 5,452 cow-calf units per month, or about 606 units for 9 months. The potential stocking rate, if excellent condition (76 percent of climax vegetation) were reached, is about 7,730 cow-calf units per month or about 859 for 9 months.

The average condition of the rangeland in the proposed disturbance area is excellent, about 83 percent of climax vegetation. The recommended stocking rate is about 33 cow-calf units per month or about 4 units for 9 months. The potential stocking rate is identical. Recommended stocking rates for alternatives vary from 22 to 74 cow-calf units per month.

TRANSPORTATION

The roads that would be most affected by the proposed project are Federal Aid Secondary (FAS) 419 between Absarokee and the minesite and Federal Aid Primary (FAP) 78 between Columbus and Absarokee (fig. S-1). FAS 420 would also be affected, but to a lesser extent.

Federal Aid Secondary 419

FAS 419 is an improved two-lane roadway constructed in the early 1940s by the Montana Department of Highways (MDOH) and the U.S. government to provide improved access to the Benbow and the Mouat mines. Neither mine now operates; the roadway functions as the main route serving the communities of Fishtail, Dean, and Nye, as well as the numerous ranches and new rural developments. Area ranchers occasionally move livestock along and across the road. Recreational and tourist traffic also use this route to get to resort ranches, fishing access sites, Woodbine Campground, and the trailheads in Custer National Forest (HKM Associates, 1981, p. 5).

Average daily traffic (ADT) has been increasing on FAS 419 at a rate of 3.5 to 4.0 percent per year from 1970 to 1980 (HKM, 1981, p. 16). The 1980 ADT was 355 vehicles per day. Traffic counts made along FAS 419 declined to 324 in 1981. In 1982 ADT stood at 402; in 1983 at 282 (MDOH, 1983, p. 173). In spite of such recent erratic ADT counts, traffic is expected to grow at rates similar to those experienced between 1970 and 1980.

Both FAS 419 and FAP 78 have accident rates higher than the overall state rate. During the period January 1, 1977, through April 30, 1981, there were 90 reportable accidents on FAS 419, yielding an accident rate of 8.49 accidents per million vehicle miles (HKM, 1981, p. 18), which compares to a statewide rate of 2.89 on the secondary system. Three people were killed and 60 were injured in the 90 accidents.

III-78 / Transportation

The major existing problems with FAS 419 include a lack of shoulders, a number of inadequate bridges and sharp curves, inadequate signing, poor road surface condition, poor drainage, and narrow right-of-way in some areas (HKM 1981, p. 60). The design capacity of FAS 419 as now constructed is approximately 330 vehicles per hour or an ADT capacity of 2,200 (HKM, 1981, p. 63).

Bridges

There are 10 structures on FAS 419 that are classified as bridges (HKM, 1981, pp. 29-30). Trucks hauling ore and supplies from and to the minesite and mill may have to cross these bridges, depending on the route taken.

Bridges along FAS 419 are in various conditions. Only three of the 16 inspected were rated as good bridges and five received a low rating (HKM, 1981, p. 69). The other eight bridges had faults such as inadequate or no bridge rails, deteriorated concrete endwalls and wing walls, decayed and failed timber stringers, and deterioration of asphalt topping. Additionally, two of the ten bridges are single lane (HKM, 1981, pp. 56-59). Warning signs such as load limit, approaching bridge, and narrow bridge are lacking, none of the bridges has approach rails, and most have serious deficiencies in bridge deck rails (HKM, 1981, p. 31). Three bridges have load limits of under 70,000 pounds for a semitractor and trailer (HKM, 1981, p. 69).

The bridge (milepost 0) near the junction of FAS 419 and FAP 78 has been identified for improvement by the Montana Department of Highways. Project engineering is scheduled for 1988, with construction awaiting funding availability (Bill Strizich, Chief, Project Analysis Bureau, MDOH, pers. com., March 6, 1985).

The 1981 estimated cost to repair the bridges without the Stillwater Project was approximately \$364,000. The cost of bridge repair with the project was an additional \$91,400 (HKM, 1981, p. 91).

Federal Aid Secondary 420

FAS 420 is a gravel surface road for approximately 13 miles of its length between Absarokee and Nye. FAS 420 has experienced fluctuating traffic counts, followed recently by ADT declines. In 1980, the ADT was 236; in 1981 it increased to 304 and then declined to 274 in 1982 and to 183 in 1983 (MDOH, 1981, p. 203, and 1983, p. 173).

The accident rate for FAS 420 from 1978 to 1982 was 5.14 accidents per million vehicle miles. This rate is above the statewide accident rate for secondary roads, but below the critical rate of 7.08 for secondary roads.

One bridge along FAS 420 at milepost 0 near Absarokee is scheduled for upgrading. Project engineering will be completed in 1988, with construction commencing when funding is available (Bill Strizich, Chief, Project Analysis Bureau, MDOH, pers. com., March 6, 1985).

Federal Aid Primary 78

FAP 78 was built in 1935 and improved in 1945 by the MDOH. It serves as the main north-south highway in the region. Traffic on FAP 78 remained fairly constant between 1975 and 1980 and in 1980 stood at 1,160 ADT (MDOH, 1981, p. 136). Traffic counts made on FAP 78 below its junction with FAS 420 declined to 1,140 in 1981 and then increased to 1,240 in 1982 and 1,270 in 1983 (MDOH, 1983, p. 108).

From 1976 to 79, there were 99 accidents on the stretch of FAP 78 between Columbus and the Fishtail cutoff (CDM, 1981, 2.9-12). The accident rate was 3.35, which compares to a statewide rate of 2.50 on the primary system. Seven people were killed and 35 were injured in the 99 accidents.

The major existing problems with FAP 78 include deteriorated foundations and road surface, poor drainage and a poor safety record. The MDOH currently considers 9.4 miles of the 15.8-mile segment northeast of Absarokee as deficient (MDOH, 1980, p. 93). FAP 78 has a design capacity of 450 vehicles per hour or an ADT capacity of 3,000.

FAP 78 has substandard alignment and size. Therefore, the section between Fishtail (milepost 27.4) and Columbus (milepost 46) has been scheduled for complete reconstruction. Project engineering is scheduled for 1991, with construction beginning when funds are allocated to the project (Bill Strizich, Chief, Project Analysis Bureau, MDOH, pers. com., March 6, 1985).

RECREATION

National Forest Recreation

The main national forest lands affected by the Stillwater Project, owing to their proximity to roads, would be the drainages of the Stillwater River and of East and West Rosebud creeks. The project may also influence peripheral areas, but to a minor degree.

About 336,000 acres of national forest system lands lie in the Stillwater and Rosebud drainages, all on the Beartooth District of the Custer National Forest. Of this total, 233,000 acres lie within the Absaroka-Beartooth Wilderness and 103,000 acres lie outside. The wilderness covers most of the lands near the Stillwater Project. In the Rosebud drainages it excludes only a narrow corridor along the roads and the north face of mountains; in the Stillwater drainage it generally follows the south side of the minerals complex (fig. III-19).

The Beartooth Mountains are characterized by majestic peaks, deep canyons with narrow bottoms and sheer walls, high tundra plateaus, glaciers, and swift, cold streams. The highest point in Montana, 12,799-foot Granite Peak, is located at the head of East and West Rosebud creeks. The national forest boundary is located at the break between foothill grasslands and steep, timbered mountain faces.

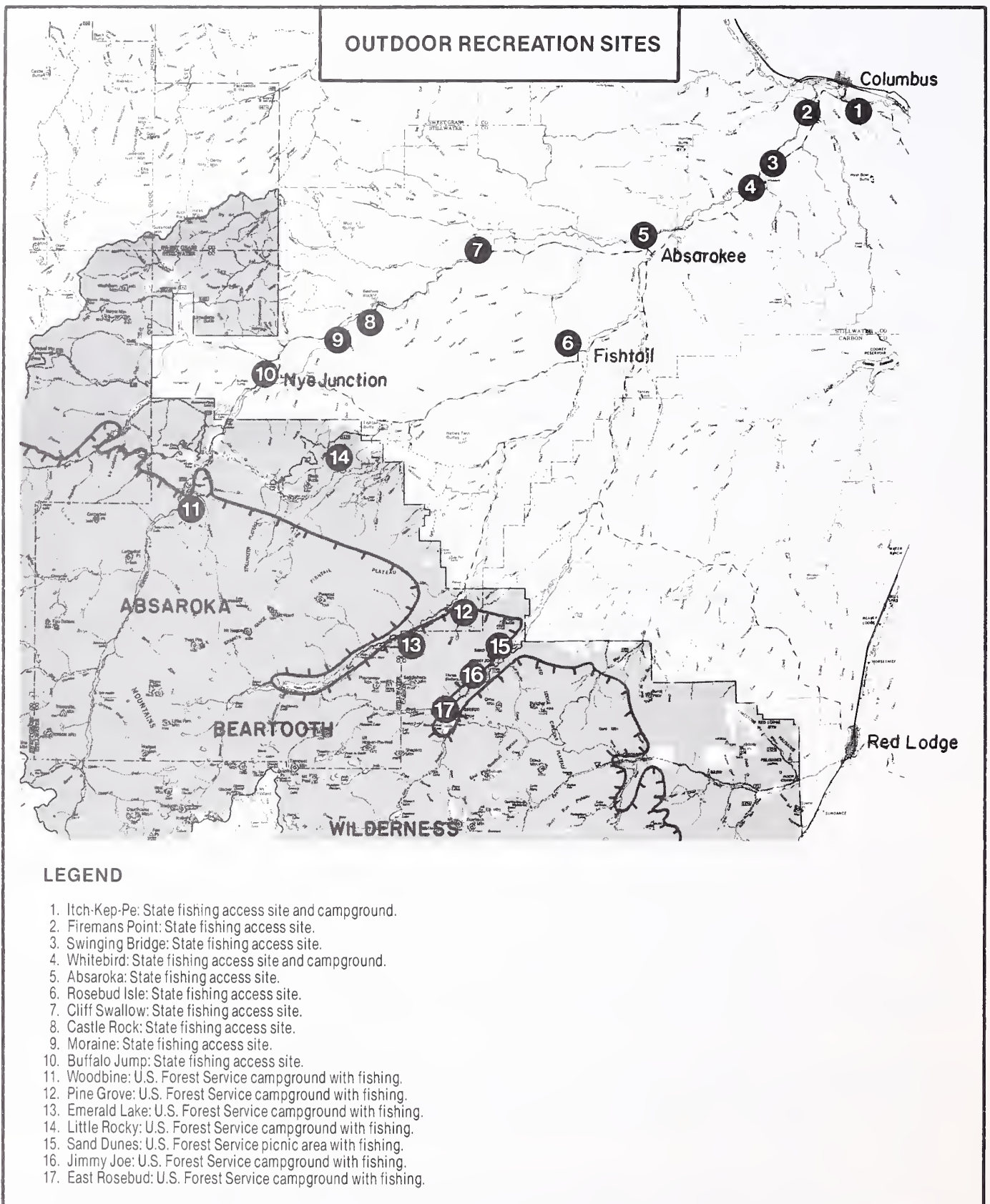


FIGURE III-19

Within the Stillwater and Rosebud drainages are 17 public recreation sites, in addition to 336,000 acres of national forest system lands. Just south of the project area lies the Absaroka-Beartooth Wilderness, which can be entered on foot from a trailhead at Woodbine Campground.

Each major stream is paralleled by a road that ends five to seven miles inside the forest boundary. Along the roads in East Rosebud, West Rosebud, and Stillwater canyons lie campgrounds, picnic areas, fishermen parking areas at lakes, and trailhead parking areas. (See tables III-16, III-17, and III-18.) Generally, less than one-half mile of trail links the trailheads with the wilderness boundary. The exception is in West Rosebud Canyon, where the boundary is about six miles from the trailhead.

The canyon of the West Fork of the Stillwater is accessed by FR 846. The distance from the mine area to the end of the road is about six miles. There are two small parking areas at the end of the road with very limited camping

TABLE III-16

Developed Campgrounds and Picnic Areas

Campground or Picnic Area	Number of Camp or Picnic Units	Persons at One Time (PAOT) Capacity
East Rosebud Lake	12	60
Jimmie Joe	10	50
Sand Dunes (picnic)	10	50
Emerald Lake	28	140
Pine Grove	46	230
Woodbine	46	230
TOTAL	152	760

Source: Recreation Improvement Records, Custer National Forest.

TABLE III-17

Developed Trailheads and Constructed Parking Areas

Name	Vehicle Parking Capacity
East Rosebud Trailhead (horse ramp)	40
Senia-East Rosebud Trailhead	5
Phantom Creek Trailhead	10
West Rosebud (Mystic) Trailhead	45
West Rosebud Lake Fisherman Parking (4 areas)	40
Emerald Lake Fisherman Parking (2 areas)	25
Woodbine Trailhead (horse ramp, corral)	50
Woodbine Falls Trailhead	8
West Fork Stillwater Trailhead (2 areas)	12
TOTAL	235

Source: Recreation Improvement Records, Beartooth District, Custer National Forest.

TABLE III-18

Occupancy Spots¹ on Public Roads--Number and Capacity

Road	Total Camp Units	Existing	PAOT ² Potential
Picket Pin Road	6	30	0
Meyers Cr.-Lodgepole Cr.	10	50	0
West Fork Stillwater (Initial Cr.)	8	40	0
Main Stillwater	12	60	0
Benbow Road	8	40	0
West Rosebud	17	35	50
East Rosebud	34	100	70
Red Lodge Cr.	15	75	0
TOTAL	110	430	120

Source: 1979 and 1980 Inventories, Beartooth District, Custer National Forest.

¹An occupancy spot is an undeveloped site used repeatedly for camping and/or picnicking. Potential site is defined as physically usable, but currently unused for some reason--generally poor vehicle access.

²Capacity in "people at one time" that can use the site.

space. In addition, a primitive camping area, with a corral and horse ramp, lies at Initial Creek, about one-half mile before the end of the road. The Benbow, Picket Pin, Meyers Creek-Lodgepole, and Red Lodge Creek roads service no developed recreation sites, although undeveloped camping areas lie beside the roads.

The nearest large population center is Billings, Montana, about 2 hours driving time away. Billings and the Yellowstone Valley area supply about 70 percent of the national forest recreation visitors to the lands near the project.

Most recreation use occurs during the summer from mid-June through Labor Day weekend (tables III-19 and III-20). Weekend use is much higher than weekday use. Winter use appears to be increasing but use levels are unknown. Woodbine Campground and Trailhead are accessible and used almost year-round. West Rosebud Road is kept open year-round to serve people living at the Mystic Power Plant. East Rosebud Road is not plowed beyond the national forest boundary, and access to the end of the road is generally limited to May through November.

Public access to national forest lands is limited to the eight roads listed in table III-18. Most summer recreation use takes place in the canyons with fishable streams and lakes. These areas have reasonable public access, except during the big game hunting season, according to the Forest Service.

TABLE III-19

Campground Use--Average Number of Units Occupied by Month and Year

Campground	Month	1980			1981			1982			1984			Average Percent of Capacity
		Average* Units Occupied	Percent of Capacity	Percent Average* Units Occupied	Percent of Capacity	Percent Average* Units Occupied	Percent of Capacity	Percent Average* Units Occupied	Percent of Capacity					
Woodbine	July	26	56	23.7	51	15.9	34	14.9	32	43				
	Aug.	26.9	58	24.5	53	14.7	32	11.0	24	42				
Pine Grove	July	23.2	50	24.3	52	17	37	10.5	23	40				
	Aug.	16.1	35	18.7	40	26.2	56	9.0	20	38				
Emerald Lake	July	24.7	83	19.6	65	19.3	65	13.8	46	65				
	Aug.	19.4	65	17.9	60	19.2	65	15.5	52	60				

Source: Recreation Use Records, Beartooth District, Custer National Forest.

*Based on 16-20 counts per month and from user fee records.

TABLE III-20

Average Daily Trail Use

Month	East Rosebud Trail			West Rosebud Trail			Stillwater Trail		
	1979			1979			1979		
	1979	1980	1981	1979	1980	1981	1979	1980	1981
June	35	30	47	35	26	30	52	50	46
July	63	54	60	41	41	48	59	79	73
August	71	64	54	40	43	45	61	61	65
Sept.	35	26	35	27	15	20	40	22	41
TOTAL Visitors for a 4-month period	6,254	5,338	5,994	4,371	3,834	4,683	6,480	6,500	6,888
Change from previous year		-15%	+12%		-12%	+22%		0%	+6%

Note: Accuracy of samples from electric eye counters initiates composite error factor of ± 1 . Figures are in total numbers of people.

Some parts of the forest boundary are without public access. This situation exists between West Rosebud and the Benbow Road and along a 13-mile stretch of the national forest boundary just northwest of Nye. Most private landholders permit selective entry through their lands, but some are restrictive.

Demand exceeds supply for improved recreation space on national forest lands on holiday weekends and occasionally on other weekends. The average daily use of most campsites is in the 40 to 60 percent range for July and August. Typically, visitors arrive on Friday afternoon or evening and depart around noon on Sunday. This pattern creates a traffic load from 3:00 to 9:00 p.m. on Friday and from 1:00 to 6:00 p.m. on Sunday. The overload persists all the way to Columbus. Expected growth in future use, if the project were not to occur, is presented in table III-21.

All of the land in the study area will carry a certain number of visitors through time without biological degradation. This capacity varies with numbers, length of stay, habits of the visitor, and individual site factors. At the present time, on the national forest, the biological capacity has not been reached, although some sites have been closed to camping and building of fires to allow recovery.

The carrying capacity estimates shown in tables III-18 and III-22 are based on an intensive level of management. This requires at least five recreation staff in the Stillwater River and West and East Rosebud Creek drainages. As the level of management drops, the U.S. Forest Service estimates that the carrying capacity will drop. No effort was made to determine the social carrying capacity of the area.

Recreation Outside the National Forest

People also participate in dispersed activities outside national forest lands, including kayaking, canoeing, and rafting along the Stillwater and Yellowstone rivers, and fishing at 11 access sites owned by the Montana Department of Fish, Wildlife, and Parks (Camp Dresser and McKee [CDM] May 1981, p. 2.10-84). (See fig. III-19.)

The use of fishing access sites on the Stillwater River is high, according to the Department of Fish, Wildlife, and Parks. Most sites are used for picnicking as well as fishing. Visitor use of the 11 sites in 1982 ranged from 4,100 visitors at the Moraine site to 13,400 at Indian Fort, with the exception of Absarokee site, which had an estimated 500 visitors (Roy Burnsten, Regional Park Manager, Montana Department of Fish, Wildlife, and Parks, oral com., March 1982).

The state of Montana owns three campgrounds in Stillwater County with a total of 43 campsites, and 8 picnic grounds with a total of 60 sites. There is also one private campground in the county; it has 20 sites (Montana Department of Fish, Wildlife, and Parks, 1978).

Two commercial dude ranches and three outfitters operate in Stillwater County. Use is primarily by people from outside the region in the summer and fall months. Fishing, horseback riding, and hunting are the principal activities offered. Besides the activities themselves, of great importance to the

TABLE III-21

Recreation Demand Trends for the
Beartooth Planning Unit

Category of Recreation	Forecasted Growth
Primitive (backpacking, mountain climbing)	+1.3% annually
Hunting, fishing, woodcutting	+3.0% annually
Road-oriented dispersed recreation	+3.0% annually
Developed campground, organization camps, tours	+2.0% annually

Source: Background Reports, Beartooth Face Planning Unit, Custer National Forest, 1978.

TABLE III-22

Wilderness Visitor Capacity

Management Unit	Camping PAOT ¹	Day Use PAOT ²
East Rosebud	114	30
Phantom	28	15 ³
West Rosebud	152	100 ³
Stillwater	236	125
West Fork Stillwater	86	20

Source: Records of Beartooth District, Custer National Forest: Determination of Wilderness Carrying Capacity, October 1981.

¹People at one time (PAOT) capacity at inventoried suitable campsites in unrestricted areas along travel corridors, using acceptable camping techniques, and on a daily basis.

²People at one time that the day use area can sustain without unacceptable biological impacts, on a daily basis during the summer season. Day use includes the area visited on day hikes, which generally extend no farther than four to six miles from the trailhead.

³Includes Mystic Lake day-use area.

recreationist is the natural beauty of the surrounding area and the clean air, isolation from most manmade environment, and other more individual values (CDM, May 1981, p. 2.10-84). Seventy-five percent of Stillwater County residents surveyed state that they are satisfied with the outdoor recreational opportunities (Entercom, 1981). Of the Stillwater County residents surveyed, the activities the largest percentage participated in were driving automobiles, hiking or walking for pleasure, picnicking, or fishing (Entercom, 1981).

Community Recreation Resources

The City of Columbus has a swimming pool, 3 parks, 2 tennis courts, and 1 basketball court. The city's public works department maintains these facilities. Columbus also has 5 baseball fields, which are maintained by the teams, and a 9-hole golf course. The course is owned by the city but operated by an association. In addition, the high school gymnasium is open for public use during nonschool hours (Briscoe, Maphis, Murray, and Lamont, Inc. [BMML], 1981).

There are also organized athletic leagues in Columbus in summer and winter and a volunteer swimming instructor during the summer. Currently, there are no plans for expansion of these recreational facilities or programs (BMML, 1981).

Absarokee also has an outdoor swimming pool and one park with two tennis courts and a civic center. The park is maintained by volunteers from the Civic Club and a lifeguard is funded by the Lions Club. There are organized athletic leagues in the summer, including a swim program. Programs are supported by fund-raising efforts. There are plans to reconstruct the Absarokee swimming pool and donate the land to the county.

CULTURAL RESOURCES

A literature and archival review of existing cultural resources information for the Stillwater Project was completed by Western Cultural Resources Management during August 1980. This was followed by an on-the-ground survey of the mine, mill, and tailing site permit area, as well as an extensive area of potential environmental effect along county road 419 and the Stillwater River. A team of archaeologists walked parallel zigzag transects to locate, examine, map, photograph, sketch, and record all archaeological and historic structures, features, stone flakes, debris, or similar material encountered. In addition, rock art (paintings or drawings) within sight of the study area was recorded. The report from this study is on file at the Department of State Lands and with the Forest Service (CDM, 1981).

Twenty-three cultural resource sites were located during the survey. Of these, nine were archaeological, thirteen historic architectural, and one both archaeological and historic. With the exception of one small cave, all archaeological sites are bison procurement or processing sites, stone rings, or cairns (heaps). Four areas of bison bone concentrations were located along the Stillwater River in association with a buffalo jump (cliff over which buffalo were driven). Stone rings and butchering areas were also noted at the jump. Two other bison processing and/or procurement areas were recorded elsewhere in the study area, as were other stone ring sites. The stone rings were probably habitation sites related to bison procurement. The stone cairns noted during the survey may have served as trail markers, caches (for food or weapons, perhaps), signal fires, horizon breaks for hunting purposes, or some other unknown function.

The cave site could have been used as an overnight campsite or cache, but is too small for group habitation. Evidence of butchered and burned bone fragments and local reports of aboriginal tools existing at the site suggest further research should be done.

The fourteen historic sites identified in the project vicinity included a wagon road, six sites associated with mining activity, and seven homesteads. The oldest sites date to the 1880s, and evidence the early attempts to exploit the mineral wealth of the region. Most of the homesteads were established from 1900 to 1920. These reflect the hope of the settlers for a more permanent residence and are predominantly related to agriculture and later mining activity.

One of the above sites, the buffalo jump, was identified in the 1975 Montana Historic Preservation Plan, which is an indication of its significance in Montana prehistory. In addition, the plan identified the site of the old Nye City, in the vicinity of the project area. The recent survey, however, could locate no remnants of the town. Earlier reports speculated that the town could have been totally dismantled and moved, or that remains could have been buried under mine tailings from past operations.

One of the primary objectives of the cultural resources survey was to locate sites included on or potentially eligible for inclusion on the National Register of Historic Places (NRHP). Seven of the above archaeological sites may be eligible for the National Register (table III-23), based on their potential to yield information on the prehistory of the area, and seven of the historic sites associated with mining and/or homesteading may be eligible for listing (table III-24), based on their association with significant settlement and economic patterns, their illustration of construction techniques, and their potential to yield information. Three of these sites are located on national forest lands, including unpatented claims, but only two are within the project permit boundary. The remaining sites identified during the survey are on private lands.

AESTHETICS

Visual Resources

The project area falls in the Yellowstone Rockies Character Type (USDA, Forest Service, Visual Character Types Handbook); however, CDM (1981) further divided this character type into foothill and mountainous subtypes.

Foothill Subcharacter Type

The foothill subcharacter type, located in the northern portion of the study area near Nye, comprises gently rolling, grass-covered hills with irrigated pastures and flat valley bottoms. The dominant landscape features are the Stillwater and West Fork of the Stillwater Rivers, the associated deciduous riparian vegetation, and the oblong hill located north of Nye.

TABLE III-23

Cultural Resource Sites Potentially Eligible for Listing in the National Register of Historic Places

Site Number	Site Name	Site Description	Type, Period, or Method of Construction	Location (relative to proposed action)
24SL150	Eckwortzel Site	Composite/kill site/stone	Early Archaic 5000-3000 BC/Late	Outside permit area; private land
24ST52	Cave Site	Cave	Aboriginal/Historic Euro-American (Dates unknown)	Outside permit area; private land
24ST54	Guthrie Ring Site	Stone Ring	Aboriginal/Historic Euro-American (Dates unknown)	Outside permit area; private land; bisected by road
24ST401	Keogh Buffalo Jump	Buffalo Jump	Late Prehistoric, 750-1805 AD	Outside permit area; private land
24ST55	Mikesall Site	Bison Kill or Butchering Site; Homestead	Aboriginal/Historic Euro-American (Unknown to present)	Outside permit area; private land; adjacent to road
24ST69	Ruppel Ring Site	Stone Ring Site/Historic Garbage Dump	Aboriginal/Unknown Historic Euro-American; 1930s to present	Outside permit area; private land
24ST61	Stone Feature	Subrectangular Stone Cluster	Aboriginal, unknown period	Outside permit area; National Forest lands

Note: Sites have been determined potentially eligible by the Montana State Historic Preservation Office and the U.S. Forest Service.

TABLE III-24

Historic Sites Potentially
Eligible for Listing in the National Register of Historic Places

Site Number	Site Name	Site Description	Type, Period, or Method of Construction	Location (relative to proposed action)
24ST53	Southworth Homestead	Homestead	Historic Euro-American, ca. 1903 to present	Outside permit area; private land; adjacent to road
24ST59	Lehner Homestead	Homestead	Historic Euro-American, ca. 1910 to present	Outside permit area; private land; adjacent to road
24ST65	Tandy Mine and Hudson Homestead	Mine and Homestead	Historic Euro-American, ca. 1903 to at least 1916	Outside permit area; private land
24ST66	Hertzler Mine	Coal Mine	Historic Euro-American, ca. 1920 or later	Outside permit area; private land
24ST67	Mouat Mine Property	Homestead	Historic Euro-American ca. 1914 to present	In permit area; private land
24ST58	Nickel Camp	Mining Camp	Historic Euro-American, ca. 1894 or later	Outside permit area; National Forest land
24ST62	Powder House	Mine Powder House	Historic Euro-American, ca 1906 or later	Outside permit area; National Forest land

Note: Sites have been determined potentially eligible by the Montana State Historic Preservation Office and the U.S. Forest Service.

III-90 / Aesthetics

Within the foothill area, the majority of man-caused landscape alterations are the result of ranching and agricultural activities. These alterations include fence lines, farm support structures, ranch houses, irrigation ditches, haystacks, and farming equipment. Some rustic structures increase aesthetic appeal. Most of the ranching activities do not adversely affect scenic quality. The only major visual alterations are second home/condominium developments, such as Cathedral Ranch.

The Hertzler Valley and Stratton Ranch Areas received an existing visual conditions (EVC) classification of 2 and 3 (Camp Dresser and McKee (CDM), 1981). This means that the appearance of the visual alterations of the natural landscape does not attract attention; that is, the natural appearance of the landscape is dominant. (See appendix D.)

The Horseman Flats area, while not classified by CDM, is rated at EVC of 2 by the Forest Service. That is, landscape changes are not evident to the average visitor.

The visual quality objective (VQO) for the area, based on procedures established by the Forest Service (1974), is partial retention (CDM, 1981). That is, activities may introduce new form, line, color, or texture, but the changes must remain subordinate to the characteristic landscape. (See appendix D.)

The visual absorption capacity (VAC) of the area is relatively high (in comparison to the mountainous subcharacter type) due to the higher vegetative regenerative capacity and gentler slopes.

Mountainous Subcharacter Type

The mountainous subcharacter type, located in the southern portion of the project area, consists of steeply elevated, angular landforms that rise sharply from the Stillwater River Valley floor. The landforms are primarily vegetated with conifers, with aspen and birch in the drainages. The steepest slopes are composed of talus or are exposed rock faces.

Although the majority of the mountainous section is free of visual impact, mine access roads and past and current mine development in the Nye Creek, Verdigris Creek, and Mountain View Creek areas affect scenic quality. The visual impact is most evident where roads cut across steep slopes and in along Verdigris Creek and in Nye Basin due to substrate/vegetation color contrasts. Revegetation and rehabilitation programs have been initiated on some of the disturbed areas (CDM, 12-Month Baseline Report, vol. II-1981).

The proposed mine and mill site is located in the mountainous section and has received an EVC classification of 4 to 5. The area where rehabilitation measures have been undertaken is EVC class 4, and the major disturbance areas due to past mining are ranked as EVC class 5. This means that the alterations to the natural landscape are easily noticed (class 4) or obvious (class 5).

The proposed mine and mill site has received a VQO of retention. To achieve this, the visual impact of activity cannot be evident. Activities may only repeat the form, line, color, and texture frequently found in the characteristic landscape.

The proposed minesite has two visual absorption capacity ratings: high VAC from the present access road down to the highway (FAS 419) and intermediate above the access.

Noise

No sound surveys have been conducted in the study area. Because the project site is rural with minimal traffic--250 average daily traffic count--and has no major development other than activity at the proposed minesite, the sound levels are probably low. Ambient sound levels measured at a rural farm averaged about 40 dB(A) (decibels) (Eldred, 1974). However, sound levels in the East Boulder River valley (Beak, 1982) were measured at 52 to 61 dB(A) with the largest source being the East Boulder River. In the Stillwater River valley, background sound levels can be expected to be about the same as those levels recorded in the East Boulder River valley. The major background sound sources are the Stillwater River and persistent winds.

IMPACTS OF THE PROPOSAL AND ALTERNATIVES:

PRODUCTION SYSTEMS

The impact analysis covers 20 topics, describing subject by subject the consequences of mining. At the start of each topic are two summaries: one for the proposal and one for the preferred alternative. Following the summaries is a description of the impacts all production systems would have in common. The impacts unique to each alternative are then described. Each section includes mitigating measures, or actions that could be taken to reduce or eliminate the adverse impacts projected. All the actions listed as mitigating measures are suggestions by the agencies, not proposals by Stillwater Mining Company.

GEOLOGY

Summary of Impacts of the Proposal: A landslide of the material above Stillwater Mining Company's minesite, although considered of low probability, would significantly affect the area. Eventual collapse of portions of the mine workings would present minimal long-term risk to the public. The height of the tailing dam and proximity to the Stillwater River presents the greatest potential for damage when compared with other alternatives.

Summary of Impacts of Alternative 4: Impacts caused by a landslide at the minesite and from collapse of portions of the mine workings would be similar to those of the proposal. The dam height and the distance of the impoundment to the Stillwater River would present a much lower potential for damage compared to the proposal.

Impacts All Production Systems Have in Common

Removal of Ore

Stillwater Mining Company's mineral ownership (fig. II-3) and mine plan area constitute a small portion of the 28-mile-long zone of platinum-group metals. Mining this part of the mineralized zone would have little effect on platinum-group metal reserves of the Stillwater Complex.

Geologic Hazards

The geologic impacts of the alternatives depend primarily on the location of the tailing pond. All three tailing sites used in the alternatives could, with proper mitigation, be safely developed, without major geologic impacts. Two sites--Stratton Ranch and the minesite--may require stabilization of adjacent slopes.

IV-2 / Geology

Any geologic impacts in the mine area would be the same with or without the mill.

Despite the differences, the proposal and the alternatives would share many of the same geologic impacts. Among the most important are geologic phenomena, such as landslides, rockfalls, earthquakes, and crown pillar collapse (caving in of the "roof" of the mine) that could damage the company's operation and the surrounding lands. The primary geologic concern at the tailing impoundment would be failure (slumping, sliding, flowing, etc.) of the tailing embankment or impoundment, caused by strong ground shaking from earthquakes or improper design and/or construction of the tailing dam and impoundment. The primary concerns at the minesite would be crown pillar collapse and landslides. Available data suggest that the probability of these phenomena occurring during the life of the operation (30 years) is low, if proper design and mitigating measures are followed. Furthermore, Stillwater Mining Company's mining work would probably not appreciably increase the chance that slides, rockfalls, and earthquakes would occur.

Landslides. The company's minesite lies within or close to two surface failure complexes (landslides). The underground workings would extend under one of the landslides, and would parallel both. Camp Dresser and McKee, a consulting firm for Anaconda Minerals Company (AMC), concluded that, even though many of the slope failure complexes in the project area now appear stable, "slope failure can also be reactivated by vibration, for example seismic activity or blasting, disruption of existing drainage conditions (surface or subsurface), or removal and/or deposition of material on the failure mass, either by natural processes or construction" (CDM, 1981, pp. 2.7-2.8).

Although these failures have been disturbed by past mining, including road building and tunneling on the southernmost slide, no visible movement has occurred. The 1959 Hebgen Lake earthquake caused peak particle velocities in the Stillwater Valley of an estimated 10 percent of gravity (7.1 on the Richter Scale), but caused no movement. This indicates the slides are probably stable.

In addition, a report by Oriard (1982), a geotechnical consultant hired by Anaconda Minerals Company, concluded that there was no indication of recent slope failures in the vicinity of the minesite; nor was there any indication that regional earthquake activity or previous blasting at the site had had any effect on the old landslides. In calculating the expected vibrations from the predicted underground blasting, Oriard concluded that "the proposed blasting operations will be of intensities that are far below those that would be capable of triggering adverse reactions in the (mapped) landslides at this project site." As a result, Oriard stated there is no need for further study of the landslide potential at the site nor any need for a special monitoring program.

Still, however unlikely, movement within the slides could threaten human life, buildings, roads, timber, water, and other surface resources in the area. The actual stability of the landslides cannot be reliably determined, because the factors that control slope stability are numerous, complex, and may vary over time (e.g., water saturation). The number of factors that

influence stability include the subsurface extent of potentially unstable materials, the degree of slide mass water saturation, the configuration of the underlying bedrock, and the slide material cohesiveness and shear strength.

Natural phenomena, rather than the company's activities, would probably be the cause of any slope failures. Saturation of the landslides from excessive precipitation and heavy snowmelt, or strong ground shaking caused by an earthquake, could destabilize the ancient slides. A combination of both conditions would be the most probable cause of failure.

Rockfalls. Several existing or potential rockfall areas have been identified at the minesite. The 6,550-level portal lies within one of the existing rockfall zones, an old landslide that contains numerous large boulders. As a precautionary measure, Anaconda Minerals Company constructed a concrete retaining wall to stop rocks from rolling into the portal area. The wall appears to be large enough to protect the portal area from rocks but it would do little to stop a landslide or slump. To date, no movement or appreciable rockfall has occurred as a result of Stillwater Mining Company's recent exploration work.

Earthquakes. Severe groundshaking caused by a large earthquake could cause slope failures, rockfalls, and avalanches. The 1959 earthquake at Hebgen Lake, an unusually strong earthquake for this region, is estimated to have produced peak particle velocity in the Stillwater Valley of 10 percent of gravity. No known landslides occurred as a result of this event, although several rockfalls did result. Based on the limited earthquake information available, ground shaking stronger than that is highly unlikely over the 30-year life of Stillwater Mining Company's operations (Qamar and Breuninger, 1979). Therefore, earthquakes would probably not trigger landslides in the project area during the 30-year life of the mine. Future major earthquakes could speed the deterioration of the crown pillar after mine abandonment.

Crown Pillar Failure. The company's permit application states that a minimum 20-foot-thick crown pillar would be left between the underground excavation and overlying decomposed bedrock overburden. The company concluded, based on engineering stress test data from rock samples taken in the Minneapolis adit, that a 20-foot crown pillar of competent (stable) material would not fail. Two problems exist in applying these conclusions as a basis for crown pillar thickness. First, the crown pillar would consist of rock at or near the surface, which is usually more weathered and less competent than rock deeper in the ground (such as the samples taken from the Minneapolis adit). Second, fracturing and faulting, which significantly reduce the strength of the rock, were not considered in the company's stress tests.

The additional nine adits to be driven into or near the outcrop of the mineralized zone could further weaken the adjacent crown pillar sections by opening old fractures and creating new ones. However, increasing the number of openings could improve opportunities for backfilling the stopes, and thereby enhance crown pillar stability.

Stillwater Mining Company proposes to determine actual crown pillar thickness by core drilling up from the underground workings to locate the

rock-overburden interface in advance of stoping. The company would use the core drilling to determine where excessive jointing and faulting occur. In areas of fractured and weather rock, the company would leave additional rock as crown pillar, or use rock bolts, timbers, and/or other standard mining techniques to stabilize fractured, faulted, and unstable areas. These methods are acceptable stabilization measures for the mine life and may hold up over the long run. However, in a worst-case scenario, rusting of rock bolts, rotting of timbers, and weathering of the crown pillar over hundreds or more years could cause parts of the crown pillar to collapse. (See appendix C.)

In the worst-case scenario, should the pillar collapse, the unconsolidated surficial material above the pillar would fall into the uppermost mine stope, thereby exposing the underground excavations to the surface. The exposed cavity could be up to 20 feet wide, several hundred feet long and about 150 feet deep if the sill pillar holds. Any surface expression of this kind would follow the trend of the proposed surface adits and could take several hundred to thousands of years to develop, although there is a low probability that it could occur sooner.

Another scenario is that because of the greater stresses at depth, spalling of the hanging wall and footwall would occur over time so that the spalled rock fragments would fill the gap between the walls. This spalling could fill the stopes, stabilize the walls, and prevent further collapse. If the failure occurred in this fashion, the subsidence could occur over a long period and over a large surface area, resulting in a gradual, even lowering of the overall surface.

The most probable scenario is that there would probably be some subsidence associated with the mining. However, the subsidence and collapse would probably be spotty and would occur far in the future. Spalling of wall rocks and filling from surface debris would help fill the stopes and reduce the amount of surface expression. In many areas, the mineralized zone occurs on a ridge line, so that surface waters probably would not be channeled by any subsidence. Any surface waters that flowed into the underground workings through the crown pillar area would either enter the ground water table or exit through the lower mine workings. As a result, little erosion would occur.

One way to minimize subsidence would be to backfill the mined-out areas (at a minimum the upper stopes just below the crown pillar) with waste or tailings. Even then this backfilled material would compact and could allow some minor subsidence. Stillwater Mining Company's proposed measures to mitigate subsidence represent accepted, current mining practices. The long-term risk to the public and to other resources posed by the crown pillar is probably low, based on experience in old mining districts. Stillwater Mining Company has agreed to take appropriate measures if any section should subside during or after mining, including bridging and filling. Temporary measures, such as signing and fencing would also be employed.

Wall Rock Burst and Scaling. Rock burst is the sudden and violent failure of wall rock. The platinum-mineralized rocks the company intends to mine are generally not susceptible to rock bursting. Anaconda Minerals Company, in its exploration work, did not encounter scaling (partially detached flakes of

rock) beyond that normally found in underground mining (Jim Harrower, Anaconda Minerals Company, oral com., April 16, 1982).

Miner safety is the responsibility of the company, the mining subcontractor, and the Mine Safety and Health Administration (MSHA). MSHA and Department of State Lands representatives would periodically inspect the mine for safety compliance.

Other Mineral Resources

The company's mining operation would not preclude the extraction of the nearby chromite or copper-nickel mineralized deposits. These other nearby deposits are not currently economic to mine. Any activity in the Hertzler Valley would not preclude future mining of coal or extraction of oil and gas in the area.

Blasting

Blasting underground probably would not destabilize surficial material and cause geologic hazards, since the level of groundshaking caused by blasting would be slight. Surficial blasting during exploration broke a few windows of a home one-quarter mile from the Minneapolis adit. Blasting during active mining would be underground and would not structurally damage buildings. The air blast created by underground blasting is reduced considerably by the time it reaches the adit opening. The company would mitigate any significant public nuisances. If blasting were documented as being a nuisance, the Department of State Lands could require the company to reduce air blast effects.

Mitigating Measures

To reduce the risk of collapse of the crown pillar, the measures mentioned previously, under the discussion of failure of the crown pillar, would apply. These measures include rock bolting, timbering, grouting, backfilling, and leaving thicker segments--especially under the public access road to the West Fork of the Stillwater River. In addition--

- o Stillwater Mining Company would be required by the Forest Service to furnish data on the depth of the crown pillar left after mining to indicate its degree of competence. An independent contractor would be used to confirm the adequacy of the crown pillar left after mining.
- o The Forest Service will require the upper stopes with inadequate crown pillar thickness to be backfilled with tailings, waste rock, or both.
- o The Forest Service would encourage the company to backfill waste rock or tailing in the upper stopes, regardless of crown pillar test results.
- o The Forest Service would require that all 11 portals could be backfilled and the fill material could be graded so that it blends with the adjacent slopes.

IV-6 / Geology

If, despite these precautions, the ground surface subsides or collapses, the company could (1) temporarily fence and sign the area until permanent measures could be implemented and (2) take appropriate measures to stabilize the crown pillar to prevent further subsidence. The agencies could retain sufficient bonding to correct surface subsidence problems should they occur.

Ground or surface water from the operation at the minesite could wet potentially unstable slopes or surface failures. Controlling this water would help in promoting slope stability. Mine structures (e.g., pipelines, dams, and ponds) could encroach upon such slopes. Mitigating measures to avoid any danger the encroachment might cause include avoidance of the slopes, additional geotechnical analysis, removal of the unstable material, use of thickened discharge methods, and special construction techniques that stabilize the slopes or make the structures resistant to any slope movement.

Impacts of the tailing-disposal alternatives are analyzed in each of the foregoing subsections: Impacts Unique to the Proposal and Alternatives 1, 2, 3, 4, 5 and 6. The mitigating measures; however, are common to each in that final engineering design and specifications for the tailing impoundment must be reviewed and approved by the agencies before the company could begin construction.

Impacts Unique to the Proposal

The proposed waste rock and tailing disposal methods would not adversely affect the geology of the area. Underlying geologic units are not unique. The tailing impoundment would not preclude future mining in the area. The tailing embankment would not impinge on Mountain View Creek.

Geomorphology

The reclaimed tailing pond should not appreciably change the geomorphologic character of the landscape. The pond would lie outside the 1,000-year flood plain of the Stillwater River and would be located well outside the 100-year flood plain of Mountain View Creek. The impoundment would not adversely affect stream stability or create excess sedimentation.

During construction, the tailing dam would be unvegetated and subject to heavy erosion. The company proposes to build a dike below the embankment to contain embankment sediment. After milling operations cease, the tailing dam and pond would be recontoured into the shape of a gentle dome (2 percent minimum slope), covered with salvaged topsoil, and seeded. Initial erosion rates off the dam face would probably be high, and could approach 60 tons per acre per year (estimated using the Universal Soil Loss Equation) if measures were not taken to control erosion. During final reclamation, to prevent the loss of seeds to erosion on the impoundment dam face, the company would use temporary erosion control measures, including the application of two tons per acre of straw mulch crimped into the ground. After successful revegetation, the dam face would have low erosion rates, less than 5 tons per acre per year. (See Soils and Vegetation.)

Tailing Site

Stillwater Mining Company's proposed tailing site lies downslope of an old surface failure complex mentioned previously. This old landslide appears to be stabilized and has not moved despite road construction and mine tunneling. The tailings would not impinge upon the landslide. The company proposes to line the pond. The gravels under the pond and dam are very porous and would thus also decrease the risk of slope instability.

The primary geologic hazard that could affect the stability of the tailing dam and pond is ground shaking caused by an earthquake. A large earthquake (e.g., magnitude 7) within tens of miles could cause the tailing dam to fail, but no major faults have been identified as being active within 40 miles. (See chapter III, Geology, Geologic Hazards.)

The dam would be built using downstream construction. This would keep the crest of the dam away from the finer tailings, a design preferred in earthquake-prone areas. The tailing dam would be constructed in five stages with borrow material and mine waste rock.

The company plans to inspect the pond daily for slope instability. Survey monuments, placed on the crest of each dam stage, would be periodically surveyed for settlement and lateral movement. Piezometers would be installed in the dam and foundation to check the phreatic surface level.

The proposed tailing dam design, as submitted, may present problems because there is no provision for an underdrain system to dewater the tailings and protect the dam from saturation and possible subsequent failure, particularly over the long term. The height of the proposed dam presents higher damage potential than in the other alternatives. The proximity of the dam to the river presents little room for intercepting seepage or for stabilizing a toe failure or slump of the dam if it were to become saturated. In addition, inadequate dewatering of the tailings could possibly interfere with surface reclamation after mining.

However, detailed plans and specifications for dam and impoundment construction are not yet available. The company expects to furnish these in spring of 1986. Final configuration of the dam will depend on the properties of the materials used to construct it to design standards.

Impacts Unique to Alternative 1

This alternative would be identical to the proposal, except that mine backfilling with the coarse fraction of the tailings would decrease or eliminate subsidence from crown pillar collapse. This alternative would also decrease the size of the tailing pond and embankment required for tailing disposal from 79 acres to 53 acres, or extend the life of tailing pond. Tailing reclamation could be complicated by this alternative: If the tailings consisted solely of slimes, dewatering and reclaiming the pond and embankment would be more difficult. There would also be potential risks because of the proximity of the dam to the river. However, the potential is not as great as in the proposal because of the lower dam height.

IV-8 / Geology

The primary geologic concern at the tailing impoundment would be failure (slumping, sliding, flowing) of the tailing embankment or impoundment, caused by strong ground shaking from earthquakes or improper design and/or construction of the tailing dam and impoundment.

Impacts Unique to Alternative 2

The Stratton Ranch tailing site, although acceptable, would cover some unstable ground. The north end of the dam and pond would overlie part of the toe of the Cathedral Mountain landslide. As the impoundment is raised, the tailings could load (weight down) and increase the water content of this portion of the slide, possibly decreasing stability. Special drainage measures, such as drain tiles and the channeling of surface waters, could prevent slope destabilization. Otherwise, water, acting as a lubricant, could cause localized failure (slides).

On the steep north- and east-facing slopes beside the impoundment site, the soils may be prone to stress failures, such as soil creep and slump. Excavating and using the surface material in dam construction would help in avoiding these failures.

Anaconda Minerals Company's consultant (Wahler, 1981) has determined in a geotechnical analysis of the Stratton Ranch site that borrow material could be taken from the Cathedral Mountain landslide. A slope stability analysis would be necessary to determine at what grade the cut slopes in the landslide material would be stable.

The concerns over crown pillar collapse and surface subsidence would be the same as with the proposal. The concerns over tailing dam siting and construction would be similar to the concerns in the proposal. The potential for dam failure may be higher at this site than under the proposal, due to the high water table and clay content of the Cathedral Mountain landslide material. The potential for damage, however, is less than under the proposal, owing to the lower dam height. In addition, there would be more room for corrective action if failure were to occur.

Impacts Unique to Alternative 3

This alternative is similar to alternative 2, with two differences. Alternative 3 has the significant advantage of a reduced chance of subsidence at the mine. The company would fill the mine stopes with tailings, adding support to the underground workings. This would not eliminate the chance of crown pillar collapse but would reduce or eliminate the possibility that a large sinkhole would develop at the surface.

A disadvantage of this alternative (as in alternative 1) is the high water content of the tailings. Since in this alternative the pond would be filled with tailing slimes only (see chapter II), the pond would take longer to dry out than one filled with mill-run tailings, as in the proposal and alternatives 2, 4, and 5. If the hypalon were to leak, the wetness could

aggravate slope instability, particularly on the Cathedral Mountain landslide. The prolonged time necessary for the impoundment to dry out could also delay or impair reclamation. The lower dam height is safer.

Impacts Unique to Alternative 4

In this alternative, the dam would be constructed with sand, cycloned from the tailings. If the dam were built with the same design features as Anaconda Minerals Company originally proposed (i.e., underdrain system and sump pumps), the dam would be stable under most conditions. The lower dam height again is better from a safety standpoint. A dam constructed from earthen materials, however, is generally better because of better construction control and material stability. A significant advantage of this alternative is that if dam failure or seepage were to occur there would be more room to take corrective action before contaminants reached the Stillwater River.

The slurry line, routed in the borrow pit along FAS 419, would pass by some unstable slopes near the Buffalo Jump. Although the line could be routed around most of the unstable slopes, line failure could occur, although the possibility of failure over the 30-year life of the mine is very low. Any spills would be minor and contained in the road borrow pit.

The concerns over crown pillar collapse and surface subsidence would be the same as with the proposal.

Mitigating Measures

The following mitigating measures would help reduce the chance of slurry line failures: removal of the unstable material, slope stabilization techniques, special anchors, pipeline reinforcement, or similar special measures. Slope movement, causing line rupture, could then be minimized. Additional precautions, such as placing the slurry line inside another pipe, would be taken where the line crosses the West Fork of the Stillwater River.

Impacts Unique to Alternative 5

The impacts from this alternative would not differ significantly from alternative 4, except concerns over a slurry line would not exist.

Impacts Unique to Alternative 6

As in alternative 4, the slurry line could pass near a few unstable slopes. With the help of special construction, the probability of failures affecting the line would be very low.

As in alternatives 1 and 3, the chance of ground subsidence would be reduced, as a result of filling the mine with tailings.

The size of the area disturbed at the Hertzler Valley impoundment site in this alternative would be less than in alternative 4. Anaconda's geotechnical studies indicate adequate sources of borrow material at the site for construction of the earthen dam. Prolonged wetness from tailing slimes, however, could delay or impair impoundment reclamation.

HYDROLOGY

Summary of Impacts of the Proposal: Mine development would have no greater impact than has exploratory development on surface or ground water quality. The mine would probably discharge about the same amount and quality of water as during exploration. Detectable, but insignificant, increases in nitrate and total nitrogen concentrations in alluvial ground water would continue downstream of the mine. Water quality of the Stillwater River would be unaffected.

Very high flood flows (greater than the 1,000-year flood) could encroach on the tailing impoundment, contributing sediment to the Stillwater River. During such a flood, however, the sediment load would be so high from natural sources that the added mine-related sediment would be undetectable.

The proposed tailing impoundment would be located near the Stillwater River. Failure of the dam could introduce tailing water and solids into the river. An underdrain system in the dam would reduce the chances of dam failure.

Summary of Impacts of Alternative 4: Seepage of water out of the percolation ponds would continue to increase nitrate and total nitrogen concentrations in the alluvium downstream of the mine. As with the proposal, the alluvial quality would be similar to what exists now, which meets drinking water standards.

The tailing pond would be located in a small drainage that flows into the Hertzler Valley, well away from the Stillwater River. Even extremely high flood flows or failure of the dam would not degrade the surface water quality of the Stillwater River, since the Hertzler Valley is relatively flat and porous.

Impacts All Production Systems Have in Common

The mine would use a portion of the ground water encountered during mining for such purposes as running the mill and cooling drills. Excess mine water would be sent to the percolation ponds. No direct surface water discharges to the Stillwater River would occur.

Up to 6 wells located a few miles downstream of the mine may have already experienced increased nitrate and total nitrogen concentrations due to seepage from existing percolation ponds. Elevated concentrations would continue and possibly increase slightly if more mine water is produced. Measured nitrate and total nitrogen concentrations next to the percolation ponds have and would continue to be well below drinking water limits. (See chapter III.) As such, despite moderate increases in nitrogen concentrations downstream, ground water would still be suitable for drinking. Release of mine water to the ground water system is covered under a MPDES permit issued by the Montana Department of Health and Environmental Sciences.

The concentrations of metals and other dissolved constituents in the mine water are similar to concentrations found in surrounding ground and surface water. The proposed ponds, therefore, would not change alluvial ground water quality except for nitrogen compounds. Stillwater Mining Company would maintain the percolation ponds as long as deemed necessary by the Montana Department of State Lands and the Montana Department of Health and Environmental Sciences.

The Stillwater River would not be influenced by percolation pond seepage (see chapter III) or the consumptive use of water at the mine.

Continued mine development would dewater more bedrock than what already has been dewatered during exploration excavations. Because of the discontinuous nature of bedrock ground water movement (fracture-controlled), the area of influence around the mine is expected to remain fairly small. No significant springs, except for the one immediately downslope of the mine and on the mine property, are expected to be affected by mine development.

The mill would not change the quantity or quality of ground or surface water. Spills of milling compounds would probably occur within the mill building, where cleanup would be easy. The company would be required to quickly attend to outdoor spills. Cleanup procedures for each chemicals used at the mine are reviewed and approved prior to operation.

After the milling reagents in the tailing slurry leave the mill, they would enter the tailing pond. Based on the following information, the mill reagents would not be expected to present a significant environmental hazard: (1) the expected concentrations of these reagents that would reach the tailing pond would be low, (2) the general toxicity of reagents is low, even at the concentrations that would reach the tailing impoundment, and (3) the amount of tailing water seeping into the ground water would be very small in comparison to the total amount of ground water flowing through the valley. (See appendix B.)

Mitigating Measures

Due to the uncertainty of the assessment of the mine development's affects on the springs, the Forest would require Stillwater Mining Company to monitor certain springs that could be potentially affected.

Impacts Unique to the Proposal

Stillwater Mining Company proposes to locate the mill and tailing pond on the relatively flat valley bottom adjacent to the mine. Runoff water from the mill and office buildings would flow into the lined tailing impoundment. The synthetic membrane liner (36-mil hypalon) would prevent seepage from reaching the Stillwater River. Even if the pond were unlined, it would pose a minimal hazard. The milling reagents (see appendix B), soluble metals, and dissolved solid concentrations in the pond water would be well below the toxicity levels for even the most sensitive of aquatic life. Pond water seeping into the ground water would be diluted by the rather high alluvial ground water flow in the valley and further diluted in the Stillwater River.

The company could prepare a pollution-control contingency plan to plan a prepared response to unanticipated leaks or spills from the tailing impoundment.

The impoundment would be located outside the 100-year flood plain of Mountain View Creek and the 1,000-year flood plain of the Stillwater River. Higher flood flows could encroach onto the base of the tailing pond. Even a heavy protective layer of coarse boulders (riprap) would not protect the pond's embankment from eroding during such high flows. Reducing the size of the impoundment or placing the pond at another location would be the only way the tailings could be protected against such high flood flows. (See alternatives 1, 3, 4, 5, and 6.)

Erosion of some of the impoundment embankment by very high flood flows would add to the suspended and bedload sediment of the river, but the amount added would be so small and the relatively inert tailings so diluted that it would be undetectable downstream of the mine.

Stillwater Mining Company proposes to maintain the impoundment dam height well above the tailing-water level, allowing complete containment of all runoff water from the 240-acre drainage area upslope of the pond. During the first half of the pond's life, the pond would be capable of storing half of the maximum probable flood (MPF) generated by the drainage above the impoundment. Thereafter the impoundment would be designed to retain the entire MPF event. The company may also include a spillway completed in bedrock as an added measure of protection if it is required by federal or state regulatory agencies.

The impoundment would eventually reach full capacity. At that time, or sooner if the mine were to shut down, the pond would be dewatered, regraded, and revegetated. Following successful revegetation, little, if any, precipitation falling on the site would infiltrate into the tailings. The minesite normally receives less than 15 inches of precipitation. Most, if not all, this moisture would be lost to evaporation or plant uptake. As such, the tailings would not pose a long-term water quality hazard, even if the membrane liner were to deteriorate over time.

Impacts Unique to Alternative 1

Compared to the proposal, this alternative would further reduce the possibility of erosion of tailings or dam material during a large flood. By backfilling over half of the mill tailings, the impoundment would be smaller. A smaller pond could be located at a greater distance from Mountain View Creek and the Stillwater River. Greater distance and increased elevation means the impoundment would be less susceptible to erosion caused by large flood events in either drainage.

Impacts Unique to Alternative 2

Tailings entering the tailing impoundment at the Stratton Ranch would have to be transported from the mill via a 2-mile-long slurry line. The likelihood of a large failure of the slurry line or of slurry dumping into the Stillwater River is low.

The tailing impoundment would abut an existing landslide deposit. Even careful design and construction of the impoundment may not be able to assure complete slide stability. Failure of the impoundment (e.g. during a severe earthquake) could send tailings into the river, although an earthquake large enough to destabilize the impoundment would probably destabilize other areas. Therefore, the site poses only a small risk; the incremental load of sediment contributed by a tailing impoundment failure would probably be small.

Very high flood flows in the tributary stream flowing along the southern edge of the Stratton Ranch site or in the Stillwater River could, as at the minesite location, introduce dam and tailing material into the river. The risk of this occurring at the Stratton Ranch site is no greater than the flood risk under the proposal.

Impacts Unique to Alternative 3

By reducing the size of the impoundment, a much larger flood event in the Stillwater River would have to occur before flood waters would encroach onto the impoundment. (See alternative 2.)

Impacts Unique to Alternatives 4 and 6

The slurry line from the mill to the Hertzler Valley would be about 7 miles long, following the Stillwater River most of the way. Rupture of the slurry line could send tailings directly into the river. The likelihood of such a failure is remote and adequate safeguards such as ditches along the line and occasional collection ponds could be used to greatly decrease the hazard. If such measures were implemented, the consequences of a slurry line rupture would be reduced.

The tailing pond would be located on the flanks of the Hertzler Valley in a small drainage. Since the site has almost no drainage area above it, even high flood flows would not introduce dam material or tailings into the Stillwater River.

Slump failure of the tailing dam, a very remote possibility, would deposit tailings and dam material on the flat hay fields of the Hertzler Valley bottom. Little, if any, sediment from such a slump would reach the Stillwater River.

Most of the seepage out of an unlined impoundment would be collected and returned to the system via an underdrain and sump pump system similar in design to what Anaconda Minerals Company originally proposed. The quality of ground water in the Hertzler Valley and the Stillwater River could be adequately protected via such a system.

Impacts Unique to Alternative 5

Placing the tailing impoundment in the Hertzler Valley would eliminate the possibility that a large flood event would introduce tailings or dam material into the Stillwater River. (See alternatives 4 and 6.)

Transporting ore to the mill via trucks would not affect surface or ground water quality.

SOILS

Summary of the Impacts of the Proposal: Impacts on soils would mainly stem from loss of soil organic matter and a reduction or loss of important soil microorganisms. Because of the loss of organic matter, postmining water- and nutrient-holding capacity would be low. This decreased capacity could result in lower vegetative density during the initial reclamation years. A loss of, or reduction in, soil microorganism populations caused by prolonged soil storage could result in lower species diversity and vigor for several years following initial revegetation.

Summary of Impacts of Alternative 4: The soil impacts of alternative 4 would be the same as those for the proposal, assuming the company would propose a similar soil salvage and handling plan. However, the impacts caused by the loss of soil organic matter and the loss or reduction of soil microorganism populations would be more difficult to mitigate under this alternative. The company could not change its soil salvage and handling plans and salvage soils in two lifts under this alternative due to the large quantities of stones and boulders in the soils at the Hertzler site. Other, more intensive, mitigations would have to be implemented at this site.

Impacts All Production Systems Have in Common

Soil Quantity and Quality

With few exceptions, impacts on soils at the proposed minesite (including alternative 1) would be similar to the impacts at the Stratton site (alternatives 2 and 3) and the Hertzler site (alternatives 4, 5, and 6). This assumes that Stillwater Mining Company would use the same soil salvage plans and soil amendments for the alternative sites as it is proposing for the minesite. Adequate quantities of soil are available at all three sites. In addition, laboratory analysis has demonstrated that the tailing material and other substrates are chemically suitable for plant growth and are not acid producing.

Under Stillwater Mining Company's proposal (and for all alternative sites), however, postmining soil quality would be fair at best. The company would not salvage soils in two lifts; that is, it would not salvage and store separately the surface (A₁) horizons, which contain an average of over 3 percent organic matter. The important surface horizons would be mixed with the subsoil materials and lost.

Because of the loss of organic matter and one-lift salvage, the postmining soils would have a low water- and nutrient-holding capacity. Many of the soils in the area also contain considerable amounts of gravel, further reducing the soils' capacity for holding water and nutrients. While the loss of organic matter would not cause large-scale reclamation failure, it would probably lengthen by several years the time required to reach premining vegetative densities or densities comparable to undisturbed surrounding areas. The low water-holding capacity may be partially mitigated by the semihumid climate of the area; however, most of the effective precipitation occurs between March and June. (See chapter III, Climate.) For the remainder of the season, droughtiness could become an important factor hindering revegetation. In addition, it would probably be necessary to add mineral fertilizers to the soil annually for several years, since most of the nutrients not used by the plants during a given growing season would probably be lost through leaching. The low water- and nutrient-holding capacity would remain low until organic matter increased from many years of vegetative growth and subsequent litter production.

The company is proposing to apply straw mulch at a rate of 2 tons per acre on all reclamation areas having slopes of 2:1 (50 percent) or less. For this analysis, it is assumed that the same treatments would be applied to the alternative sites. The proposed application rate is commonly used and considered effective for erosion control (Kay, 1980). Straw mulch generally improves environmental conditions for germination, survival, and early growth by conserving soil moisture and moderating soil temperatures (Wittwer et al., 1980).

The benefits from the mulch application would be very short term, however, since less than half the straw would probably remain after one season (Schuman et al., 1980). This is especially true at the Stillwater site, since the company is proposing to crimp the straw into the soil with a land imprinter. A land imprinter is designed to create geometric patterns on the soil surface to control erosion, direct infiltration, and prepare a seedbed

IV-16 / Soils

(Larson, 1980, p. 79). However, it has been found to be ineffective when used as a crimper (Dr. G.E. Schuman, USDA Agricultural Research Service, and D. Meeker, Trapper Mining Company, oral com., August 20, 1984). Regardless of the implement used to crimp the straw into the soil, the remaining straw residue, when decomposed, would add only a negligible amount of organic matter to the soil.

Biological Soil Impacts

Because reclamation of the major disturbance areas (tailing pond, mill site, associated structures) cannot begin until the mine closes, a major portion of the salvaged soils would be stored for 25 to 27 years. Soil that is stockpiled for prolonged periods is biologically and physically altered (Fresquez and Lindemann, 1982; Liberta, 1981; Miller and Cameron, 1976). Biological activity is reduced, the most common cause being the anaerobic (oxygen-free) condition created in the deeper portions of the stockpile. Seeds, spores, single cells, hyphae (fungal parts), and vegetative parts may be adversely affected (McKell, 1982).

Researchers have found that soil stored for many years may have little biological resemblance to native soils. Stockpiling of soil, especially topsoil, reduces the number of important microbes (i.e., bacteria, fungi, algae), reduces nutrient mineralization and availability, increases nitrogen losses through the process of denitrification, and decreases or eliminates the important fungus-root associations known as mycorrhizae (Rives et al., 1980; Singleton and Williams, 1979; Cundell, 1977; Miller and Cameron, 1976; Davidson, 1976). All rootzone microorganisms are important to the soil ecosystem. Parkinson (1978) suggests that a knowledge of below-ground biological systems, and mycorrhizal relationships in particular, is as important as above ground information in understanding the mechanisms of plant recovery following disturbance.

Mycorrhizae are structures that develop when certain fungi and plant roots form a symbiotic (mutually beneficial) relationship. The fungi absorb nutrients and water for the plants; the plants provide carbohydrates from photosynthesis for the fungi. The mycorrhizae serve as highly efficient extensions of the plant's roots.

Mycorrhizae are an important consideration in maximizing plant productivity as most plants depend on mycorrhizae. Malloch et al. (1980) assert that four-fifths of all land plants form mycorrhizal relationships. Some plants cannot succeed without their fungal associate (Trappe, 1981). Mycorrhizae are reported to increase plant productivity by as much as 400 to 500 percent (Davidson, 1976; Mosse and Hayman, 1971; Gerdemann, 1970). Mycorrhizae are especially important to plants' phosphorus nutrition and water uptake (Christensen and Allen, 1980).

Dilution of biological components would also occur as a result of mixing the shallow, biologically-active surface soil layer with a large amount of biologically-deficient subsoils. This would result from Stillwater Mining Company's plan to salvage soils in one, rather than two lifts. The topsoil would be combined with the subsoils during removal, handling, stockpiling, and replacement.

Stillwater Mining Company's prolonged soil storage plans (although unavoidable) and proposed soil salvage plans could delay establishment of some plants (Fresquez and Lindemann, 1982) and lower postmining species diversity and plant vigor for an unknown time period. The proposed plans could also lengthen the time required for recovery to a stable, native plant community (Doerr et al., 1984). The loss of many soil microbes would be somewhat mitigated by the addition of a carbon source, such as the company's proposed straw mulch amendment or by planting a cereal grain crop. However, these amendments would have little or no effect on mycorrhizal reinfection (Lindemann et al., 1984). Migration of mycorrhizal fungi onto disturbed sites is a topic of current speculation based on a minimal amount of data (MacMahon and Warner, 1984). Artificial inoculation appears to be, at best, marginally successful on small plots (Menge and Timmer, 1982), although research is continuing (Wood, 1984).

Natural reinvasion appears to occur by several means, but the relative quantities and the ability of the inocula (spores, fungal fragments, plant parts, etc.) to survive the stresses imposed by the disturbed environment remains to be determined (Allen, 1984). Loree and Williams (1984) found that natural mycorrhizal colonization of a disturbed site was minimal after 3 years, but mean infection levels on 5- to 7-year-old sites were comparable to those of adjacent, undisturbed sites, although infection levels were highly variable. Allen and Allen (1980) found that mycorrhizal infection and spore counts in reclaimed areas increased up to 50 percent of undisturbed site levels after 2 to 3 years.

Unavoidable Soil Impacts

Some soil impacts occur whenever the natural soils are removed, stored, and replaced. These unavoidable impacts include loss of the natural soil profile and pore space continuity, an overall reduction in pore space, and a breakdown of soil structure. Because of these impacts, the reclaimed lands could be more sensitive to mismanagement and drought than prior to disturbance. These impacts would correct themselves over an unknown period of time.

Impacts Unique to the Proposal and Alternatives 1, 2, and 3

Although the impacts of the proposal and alternatives 1, 2, and 3 would not be unique, the expected low water- and nutrient-holding capacities and biological soil impacts could be easily mitigated. The Lolo soils, which cover about 63 acres (table IV-1) in the proposed disturbance area (including alternative 1) and most of the area at the Stratton site (alternatives 2 and 3), are described as having surface (A_1) horizons that average 18 inches in thickness. These soils are mapped as cobbly loams in this area. Since the surface horizons contain only about 15 to 30 percent cobbles by volume, and cobbles are defined as rounded fragments ranging from 3 to 10 inches in diameter (U.S. Department of Agriculture, 1951, p. 216), a two-lift salvage of these soils is feasible. As a mitigating measure, Stillwater Mining Company could separately salvage and stockpile the surface material for just the Lolo soils. During reclamation, this would provide a veneer of topsoil material with adequate water- and nutrient-holding capacity--better than other soils replaced throughout the disturbance area.

TABLE IV-1

Soil Resources of the Proposed Disturbance Area

Mapping Unit	Disturbance ¹ Acres	Volume of Available Soil (acre-feet)
Lead-Rock Outcrop	7.1	3.0
Lolo Cobbly Loam ²	63.2	126.4
Nesda Loamy Sand ²	0.5	0.5
Rock Outcrop-Sale Association	9.0	1.7
Rock Outcrop-Stuck Association	12.0	3.7
Sebud Stony Loam ²	60.3	58.0
Taxi Stony Sandy Loam	4.0	0.7
Tomy Stony Sandy Loam	3.1	4.6
TOTAL	159.2	198.6

Source: Stillwater Mining Company, 1984a.

¹Although Stillwater Mining Company is proposing a 165-acre disturbance area for planning purposes, the company states that this estimate is conservatively high, and not all of the soils within this area would be disturbed. For example, soils under the proposed soil stockpiles and along the minesite power corridor would not be disturbed.

²Official, established SCS soil series. Series names given in other mapping units are unofficial, and are intended for local identification only.

Two-lift soil salvage could also mitigate other biological impacts at the minesite (including alternative 1) and Stratton site (alternatives 2 and 3). The biologically-active surface horizons could be placed in a separate stockpile. To maintain the organisms in the stockpile, the pile's surface area could be increased by spreading out the topsoil over a greater area. The stockpile could then be immediately planted with native species so that the organisms present in the soil would persist throughout the life of the stockpile.

The reason for spreading out the soil over a greater area is that only in the upper foot or so of any stockpile can mycorrhizal fungi and other important organisms survive and function, since they require oxygen. (Mycorrhizae also require host plants.) An expanded pile would sustain more soil microorganisms, and a greater opportunity would exist for reinfection during final reclamation.

Impacts Unique to Alternatives 4, 5, and 6

The soil impacts at the Hertzler site (alternatives 4, 5, and 6) would be the same as those discussed earlier for the other sites. However, ways to mitigate these impacts would be different. Two-lift soil salvage would be impossible, since most soils at the site contain large quantities of stones and

boulders. However, mitigating measures do exist that would increase the water- and nutrient-holding capacity of these soils. (These mitigations could also be applied to the minesite and Stratton site soils should the company choose not to salvage soils in two lifts where possible at these sites.)

Organic matter could be added in the form of manure or as an annual cereal grain crop such as Otis barley. Manure, if available locally in adequate quantities and incorporated into the soil surface, would increase the water- and nutrient-holding capacity of the soil. Manure, however, could be a source of undesirable weedy species, including noxious weeds, which is a major concern of landowners in the Stillwater Valley. Weeds can be controlled by various techniques, including spraying and burning. But because of the local concern regarding weed infestations, addition of organic matter by planting annual cereal grain crops may be a more acceptable soil amendment.

Planting annual cereal grain crops before interseeding with native perennials would have a number of advantages at the Stillwater sites. According to Schuman (USDA Agricultural Research Service, oral com., August 20, 1984), if at least 1,000 pounds per acre of cereal grain top growth is achieved, the roots would add an additional 500 to 1,000 pounds per acre of growth (organic matter) to the soil profile. This would improve the soil structure, increase water infiltration, and improve soil water- and nutrient-holding capacity. In addition, the stubble traps more snow during the winter and provides greater and longer-lasting protection to the soil than crimped straw. Chances of weed infestations are also much less with the grain stubble than with straw mulch (Schuman et al., 1980).

The following cereal grain treatment is recommended:

- o Plant an annual cereal grain crop in the spring (e.g. Otis barley).
- o Monitor the growth; mow the plants to about 1 foot in height just before the plants go to seed.
- o Incorporate the residual stubble into the soil the following spring; plant a second crop of annual grain.
- o Monitor the growth; mow again to about 1 foot in height just before the plants go to seed.
- o Broadcast (or drill seed) native perennials that fall.

The stubble and matted residue should provide adequate protection from wind erosion until native species become established.

The above mitigating measures would provide for adequate water- and nutrient-holding capacity in the postmining soils, and would be especially beneficial during dry periods that normally occur in the latter part of the growing season. (See chapter III, Climate.) Such amendments would hasten the revegetation effort and improve the chances for initial success.

The mitigations to reduce biological impacts at the minesite and Stratton site (discussed earlier) could not be applied at the Hertzler site, since a two-lift soil salvage operation would be impossible. Some biological impacts could be mitigated at the Hertzler site by addition of a carbon source, such as various forms of organic matter. This has been found to be effective in stimulating an active and varied microorganism population on disturbed lands

without topsoil; however, organic amendments appear to have little or no effect on mycorrhizal reinfection (Lindemann et al., 1984).

In the case of the Hertzler site, the company may have to depend on natural reinfection, which could take many years. It is possible, however, based on current research as well as discussions and predictions in the literature, that commercial sources of mycorrhizal fungi could be available at the time of final reclamation (Wood, 1984; Cordell and Marx, 1983; Menge and Timmer, 1982).

VEGETATION

Summary of Impacts of the Proposal: Mining would destroy 97 acres of vegetation and 68 acres of vegetation on previously disturbed land. Most revegetation (73 percent) would occur after mine closure. Low nutrient- and water-holding capacity of topsoil may cause some revegetation failures. Seeded grasses would establish an erosion-controlling ground cover in most areas. Livestock forage production would increase, primarily due to revegetation of the 68 acres of previously disturbed lands. Plant diversity, however, would decline. Trees and shrubs would be reestablished, although at densities far below premining levels. Over the long term, tree and shrub densities and plant diversity would increase. Livestock forage production would slowly decline to near premining levels.

Summary of Impacts of Alternative 4: Forty-nine acres of vegetation (mostly open-canopy forests) and 43 acres of vegetation on previously disturbed lands would be destroyed at the minesite. The tailing pond would remove an additional 179 acres of vegetation (mostly stony grassland). The six-mile slurry line would also disturb some vegetation. Most revegetation would occur after the mine closes. Assuming the general revegetation procedures at the tailing pond are similar to those used at the minesite, seeded grasses would form an erosion-controlling ground cover in most areas. Low nutrient- and water-holding of topsoil may cause some revegetation failures. Stony soils at the tailing pond would create more difficulties. Despite some localized revegetation failures, livestock forage production would increase, primarily due to revegetation of previously disturbed lands. Plant diversity, however, would decline. Diversity would slowly increase and production would gradually decrease to near premining levels. Trees and shrubs, at densities far below premining levels, would be established at the minesite. Plans for tree and shrub planting at the tailing pond site have not been developed.

Impacts All Production Systems Have in Common

Mine structures (shafts, yards, portals, percolation ponds, roads, and associated disturbances) would destroy 49 acres of vegetation within the permit area. The open-forest types would account for most of this acreage. Eight total acres of Douglas fir, lodgepole, subalpine, and aspen forests would be destroyed. In addition, 28 acres of vegetation on previously disturbed land would be removed.

Different tailing pond locations and/or sizes distinguish the proposal and alternatives from each other. (See chapter II.) Each tailing pond would create a topsoil stockpile varying from 6 to 18 acres. Total acreages of vegetation types disturbed by the tailing ponds, stockpiles, and mining structures are shown in table III-2. The emergency tailing pond required by alternatives 2, 3, 4, and 6 was assumed to cover 15 acres of previously disturbed land at the minesite.

Most of the affected land would be revegetated within 2 years after mine closure. However, some areas (dams, topsoil stockpiles, diversion ditches, and cut-and-fill slopes) would be revegetated while the mine is operating. Stillwater Mining Company may seek the Department of State Lands' approval to cover some steep slopes with rocks, creating talus slopes similar to those present today. Revegetation types are not directly correlated with premining vegetation types. The company would attempt to reach its reclamation goal of creating wildlife habitat and recreation opportunities by seeding herbaceous species and by planting containerized tree and shrub seedlings. Test plots would be established during mine operation to determine the effectiveness of revegetation plans. Plans may be modified, with the Department's approval, based on test plot results. The company would evaluate final revegetation 2 years after its completion.

General Procedures for Revegetation

Revegetation would begin with the ripping of highly compacted surfaces to improve permeability to water. Topsoil would be spread on all recontoured surfaces.

The topsoil is expected to be low in nutrient and water-holding capacity. (See Soils.) This would limit the establishment of species used during revegetation. Small, localized vegetation failures would occur, especially where coarse-textured or gravelly topsoil is used. Salvaging soils in two lifts, where feasible, as well as the addition of soil amendments, would greatly improve plant establishment and growth. (See Soils.)

After seeding, 2 tons per acre of straw mulch would be crimped into the soil with a land imprinter (a towed, rolling drum; see Larson, 1980). Soils previously treated with the land imprinter may become overly compacted.

Slopes over 2:1 would be covered with jute netting or hydromulch/tackifier or straw mulch/tackifier mixtures. Unless Stillwater Mining Company uses a "clean" mulch, introduced weeds may become established and compete with other desired species for nutrients and water (Kay, 1980). All areas would be fertilized at a rate determined by site-specific soil tests.

IV-22 / Vegetation

Seeding--Herbaceous Species

Stillwater Mining Company proposes to use two seed mixtures (table IV-2). About 20 pounds per acre of the low-altitude mixture would be broadcast seeded in areas below 5,300 feet. The company would seed above that elevation with 14 pounds per acre of the high-altitude mixture. The company retains an option of drill seeding at about half the above rates. Seeding would be done in spring (April or May) or fall (October).

Species selected for revegetation are based on premining vegetation inventories. They are generally well adapted to the project area and are expected to establish successfully where not limited by topsoil quality. Blue grama and prairie sandreed, however, both species which grow mainly during warm parts of the growing season, would be difficult to establish (F. Munshower, Montana State University, pers. com., July 23, 1984; R. Brown, U.S. Forest Service, pers. com., July 24, 1984). (See appendix E for scientific names of plant species.) They would probably be out-competed for water and nutrients by the cool-season grasses (species which grow mainly in cool parts of the growing season). As a result, warm-season grasses would grow only on small patches of favorable soil.

Although probably adequate to establish an erosion-controlling ground cover, seeding rates are lower than the 25 to 50 pounds per acre recommended for revegetation on the nearby Beartooth Plateau (Brown et al., 1976). A higher seeding rate would yield a more uniform ground cover (I.B. Jensen, Western Reclamation, pers. com., July 24, 1984).

If seeds are planted in the spring, the advantages of fall seeding would be lost. Fall planting gives seed a winter to meet cold-induced dormancy requirements for germination of some species (Brown and Johnston, 1978). Moreover, fall-planted seeds are in place to use favorable early spring moisture for germination. Often, this is earlier than seeding sites are accessible in spring due to snow and wet soils (Laycock, 1982; Brown et al., 1976).

In the past, high winds have hindered the revegetation efforts of the Anaconda Minerals Company (Department of State Lands and U.S. Forest Service, 1982). Anaconda Minerals Company planned to keep seeds in the ground by planting in the spring when winds are less. However, recent analysis of 1980-81 data suggests that fall wind speeds are not substantially greater than those in spring. (See Climate, chapter II.) Fall planting may therefore be appropriate. Mulches, drill seeding, and other measures may reduce loss of seed to wind. (See Mitigating Measures.)

Unless plant growth is severely limited by low water and nutrient-holding capacities, revegetation would increase short-term production of livestock forage in the disturbance area. Factors contributing to this higher productivity include (1) fertilization, (2) reduced plant competition, (3) generally increased nutrient availability after soil disturbance, (4) high productivity of reseeded species, (5) decreased density of woody species (see below), and (6) revegetation of land disturbed prior to Stillwater Mining Company's operations.

TABLE IV-2

Proposed Seeding Mixtures for Revegetation

Low-Elevation Seed Mixture			High-Elevation Seed Mixture		
Common Name ¹	Rate PLS (pure live seed)	Seeds per ² square foot	Common Name ¹	Rate PLS (pure live seed)	Seeds per ² square foot
Beardless wheatgrass	4.0 lb/acre	8 - 12	Beardless wheatgrass	4.0 lb/acre	8 - 12
Western wheatgrass	4.0 lb/acre	8 - 12	Bluebunch wheatgrass	4.0 lb/acre	8 - 12
Bluebunch wheatgrass	4.0 lb/acre	10 - 12	Idaho fescue		
Blue grama	0.5 lb/acre	9	Sheep fescue	2.0 lb/acre	20
Prairie sandreed	1.5 lb/acre	9	Canada bluegrass	1.0 lb/acre	40
Idaho fescue	1.5 lb/acre	15	Needle and thread	1.0 lb/acre	7
Sheep fescue			Silvery lupine or Silky lupine	0.5 lb/acre	
Canada bluegrass	0.25 lb/acre	10	Black medic		
Needle and thread	1.0 lb/acre	7	Alfalfa	1.0 lb/acre	14 - 20
Green needlegrass	2.0 lb/acre	8	Creeping foxtail ³	0.5 lb/acre	7
Arrowleaf balsamroot	0.25 lb/acre	7 - 10			
Black medic	0.5 lb/acre				
Purple prairie clover	1.0 lb/acre	5			
TOTAL	20.5 lb/acre	96 - 109		14.0 lb/acre	104 - 118

¹ See appendix E for scientific names.² Also represents the approximate percentages of each species in mixture.³ May be added when the mixture is used in moist areas.

IV-24 / Vegetation

Long-term productivity would decline to near premining levels as factors 1, 2, and 3 become less influential and as woody species invade the project area. However, short-term plant diversity would be lowered. Revegetated land would probably be dominated by the seven cool-season grasses that make up most of the seeding mixtures (table IV-2). These competitive grasses establish more readily than other species proposed for revegetation. Over the long-term, invasion by native plants would increase diversity to near premining levels.

Woody Species

Stillwater Mining Company proposes to plant 500 containerized trees and shrubs per acre on reclaimed land. Three mixtures of woody species would be used (table IV-3). Planting rates for each species would vary by revegetation site. Wood's rose would be the most often used species, constituting almost one-half of total tree and shrub planting. Lodgepole pine is of primary importance to reestablishment plans for upper elevation forests.

Even if all 500 trees and shrubs planted per acre survived, short-term postmining densities (table IV-3) would be far below premining densities (table III-2) of woody species. (Due to a lack of premining data, a comparison cannot be made for the lands disturbed by earlier mining and since revegetated by Stillwater Mining Company.) Mountain ninebark, snowberry, and Douglas fir, commonly found in forested types, would not be reestablished. The subalpine forest contains huckleberry, rusty menziesii, currant, and subalpine fir, which would not be replaced after mining. Mortality, varying by species, would further lower density of planted trees and shrubs (table IV-3). Potential obstacles to reestablishment of woody seedlings include excessive competition for water and nutrients from herbaceous species (Ferguson and Frischknecht, 1981; Fedkenheuer et al., 1980) and damage by livestock or wildlife (Penrose and Hansen, 1981; Fisser, 1981).

Over the long term, densities of trees and shrubs would increase. Native vegetation would invade reclaimed lands. Planted trees and shrubs would begin to produce seed and/or spread by root sprouting. Still, densities would remain below premining densities for the foreseeable future.

Noxious Weeds

Noxious weeds would probably not grow to any great extent on any of the reclamation areas, including roads. The company would topsoil the reclamation areas and revegetate them immediately. The reclamation areas would be monitored by the company and the agencies. If noxious weeds began to invade any specific reclamation area (which would most likely occur before planted vegetation becomes established), the company would be required to implement any management techniques necessary to eradicate the problem. In any event, the Department of State Lands would not release the company's bond until the reclamation areas have stable and desirable vegetation communities that would support the proposed postmining land use.

TABLE IV-3

Planting Rates and Estimated Mortality Rates of
Trees and Shrubs Planted During Revegetation

Revegetation Site	Species	Rate (#/acre) ¹	Estimated Mortality (%) ²	Reference For Mortality Estimate ³
Lower Elevation--				
below 5,300 feet (113 acres in proposal)	Wood's Rose	175-300	10	I.B. Jensen, pers. com., 7/29/84
	Big Sagebrush	25-200	25	Everett 1980
	Skunkbush Sumac	25-200	25	---- ⁴
	Creeping Juniper	50	40	Jackson 1982
	Chokecherry	25	16	Jensen and Hodder 1979
	Limber pine	25	40	Jackson 1982
Upper Elevation--				
above 5,300 ft (50 acres in proposal)	Lodgepole Pine	200	25	N. Stark, pers. com., 7/12/84
	Wood's Rose	150	10	I.B. Jensen, pers. com., 7/24/84
	Creeping Juniper	50	40	Jackson 1982
	Common Juniper	50	40	Jackson 1982
	Kinnikinnick	50	25	----- ⁴
Diversion and				
Drainage Ditches-- below 5,300 ft (2 acres in proposal)	Chokecherry	225	15	Jensen and Hodder 1979
	Aspen	125	58	Fedkenheuer et al 1980
	Wood's Rose	100	10	I.B. Jensen, pers. com., 7/24/84
	Creeping Juniper	25	40	Jackson 1982
	Dogwood	25	50	Fedkenheuer et al 1980

¹ Rates vary among revegetation sites.

² Mortality rates are rough guidelines for prediction purposes. Estimates were drawn from studies with altitudes and precipitation zones as close as possible to Stillwater Mining Company's project area. Some rates were adjusted to compensate for environmental differences.

³ I.B. Jensen works for Western Reclamation in Bozeman, Montana. N. Stark is employed by the University of Montana in Missoula, Montana.

⁴ Published mortality rates were not found. The rate is based on a general shrub mortality rate of 25%.

Mitigating Measures

- o Increasing the seeding rate for the high-altitude mixture would help to establish a more uniform ground cover. The proposed rate of 14 pounds per acre is far below rates used on the nearby Beartooth Plateau (Brown et al., 1976). Twenty pounds per acre may be more appropriate (R.W. Brown, U.S. Forest Service, pers. com., July 24, 1984).

IV-26 / Vegetation

- o Using creeping foxtail in the high-altitude mixture would help to increase ground cover. (The species is currently listed as an optional component of the high-altitude seed mixture.) Creeping foxtail has been recommended for high-altitude reseeding by Berg (1974), Laycock (1982), Hull (1974), and Long (1981).
- o Using the cleanest straw mulch available (least amount of weed seeds) would reduce the chances of weed introduction. A mulch of high-altitude, native range hay would probably contain few weed seed and would be an alternative to straw mulch. Limiting use of the land imprinter to one treatment per area would prevent excessive soil compaction.
- o A cover crop provided by standing stubble would offer several advantages over proposed mulches. Schuman et al. (1980) found standing stubble to be superior to mulch in resistance to wind, temperature control at the surface, water infiltration, and cost. Chances of weed introduction would also be lower. The general procedure would be to spring seed a hard, annual grain crop and interseed the revegetation seed mixture during the fall. The following spring, stubble remaining from the annual grain crop would aid in establishing revegetation species.
- o Scalping (removing grasses and weeds) or applying a short-term herbicide around individual seedlings would increase the survival of planted trees and shrubs (Penrose and Hansen, 1981; N. Stark, University of Montana, pers. com., July 12, 1984).
- o The annual fertilization of reseeded areas for 1 or 2 additional years would partially compensate for the low nutrient- and water-holding capacity of the topsoil. (See Soils.)
- o Prohibiting the grazing of herbaceous species for about 2 years would help to assure the survival of reseeded species (Laycock, 1980). Woody species would require protection for several years. Controlling cattle distribution or fencing would reduce browsing on planted trees and shrubs (Penrose and Hansen, 1980). Damage to seedlings by wildlife would be more difficult to control. Protective measures could include fencing and repellents. Monitoring and, when necessary, controlling rodent populations would also reduce damage to seedlings. Replanting of seedlings would be one way of obtaining desired densities.

Impacts Unique to the Proposal

The tailing pond and topsoil stockpile would cover 88 acres within the permit area. Open forests and previously disturbed lands would make up almost all this acreage (table III-2). About 45 acres of affected land would be revegetated while the mine is operating (table IV-4). The remaining 120 acres would be revegetated after the mine closes.

Impacts Unique to Alternative 1

This alternative would require a tailing pond of 53 acres and a stockpile of 6 acres at the minesite, reducing, compared to the proposal, the acreage of

TABLE IV-4

Proposed Revegetation Schedule and Revegetation
Species Category, Stillwater Mine

Operation Component	Acres Disturbed	Revegetation Schedule	Revegetation Species Category ¹
Tailing pond ²	49	After Closure	Low Altitude
New roads	27	After Closure	Low and High Altitude
Portals, shaft, yard	14	After Closure	High Altitude ³
Mill, associated facilities	12	After Closure	Low Altitude
Percolation pond, drainage ditch	6	After Closure	Low Altitude
Miscellaneous	<u>12</u>	After Closure	Low Altitude
SUBTOTAL	120		
Topsoil Stockpiles	10	During Mining	Low Altitude ⁴
Tailing embankment	30	During Mining	Low Altitude
Percolation pond dams	4	During Mining	Low Altitude
Diversion ditch	<u>1</u>	During Mining	Low Altitude
Cut-and-fill Slopes	<u>--</u> ⁵	During Mining	Low and High Altitude
SUBTOTAL	45		
TOTAL	165		

Source: Stillwater Mining Company, 1984a.

¹ All species used for revegetation are included in either the low altitude or high altitude categories. The diversion between the category proposed is an elevation of 5,300 feet.

² Some roads may be left in place upon U.S. Forest Service approval.

³ Portals 5,000 and 5,150 would receive species from the low-altitude category.

⁴ The small headframe stockpile would receive species from the high altitude category.

⁵ Mostly along roads. Acreage is included in the 27 acres of new roads but is currently unknown.

vegetation disturbed. Although less revegetation would be necessary, results would be very similar to proposed revegetation.

Impacts Unique to Alternative 2

This alternative would destroy about 129 acres of vegetation at the Stratton Ranch site. Soils and climate are similar to those at the proposed tailing pond site. Results of revegetation would therefore be similar to the proposal. Two miles of slurry line would require reclamation. This would include structure removal, ripping of compacted surfaces, topsoiling, and revegetation.

Impacts Unique to Alternative 3

This alternative would destroy 86 acres of vegetation at the Stratton Ranch site. Impacts would be similar to those under the proposal, except that 3 fewer acres would be affected by the tailing pond and that a 2-mile slurry line would require reclamation.

Impacts Unique to Alternative 4

This alternative would destroy about 179 acres of vegetation at the Hertzler Ranch site. A 6-mile slurry line would also disturb vegetation and require reclamation. (Revegetation of the Hertzler site would be somewhat less successful than at the proposed site due to stonier soils. [See Soils.] However, wind speeds measured at the Hertzler site are slightly less than those at the proposed site. [See Climate, Chapter III.] Wind erosion may therefore be less of a problem.)

Impacts Unique to Alternative 5

The acreage of vegetation destroyed by the tailing pond for this alternative would be the same as alternative 4 (179 acres). The mill would disturb another 12 acres. Ore truck routes would not disturb any additional vegetation. A slurry line would not be used. Revegetation of the tailing pond and mill would have results similar to those in alternative 4--somewhat less successful than for the proposal, due to stonier soils.

Impacts Unique to Alternative 6

This alternative would destroy 143 acres of vegetation at the Hertzler tailing site and require 6 miles of slurry line. Results of revegetation would be similar to those for alternatives 4 and 5--somewhat less successful than for the proposal.

AQUATIC ECOLOGY

Summary of Impacts of the Proposal: Aquatic habitat and organisms would not be affected by the proposal.

Summary of Impacts of Alternative 4: A slurry spill into the Stillwater River could occur, resulting in a temporary but sharp increase in total suspended solids. Although the specific impacts to the aquatic biota are not known, the effects would be temporary, and most likely minor.

Impacts Unique to the Proposal and Alternatives 1, 2, 3, and 5

Neither the proposal nor alternatives 1, 2, 3, or 5 would have any effect on the aquatic ecology of the Stillwater River.

Impacts Unique to Alternatives 4 and 6

Alternatives 4 and 6, slurring the tailings to Hertzler, would necessitate a slurry line crossing the West Fork of the Stillwater River. Even with all possible precautions, a slurry spill into the West Fork of the Stillwater River could occur, resulting in a temporary, but sharp increase in total suspended solids. Although the specific impacts to the aquatic biota are not known, the effects would be temporary, and, most likely, minor.

FISHERIES

Summary of Impacts of the Proposal: Fish populations would not be directly affected by mining. However, population increases in the Stillwater Valley would lead to increased fishing pressure along the Stillwater and its tributaries, possibly leading to reduced fish populations or more conservative fishing regulations.

Summary of Impacts of Alternative 4: Since the water quality of the Stillwater River would not be changed by mining, fish populations in the river would not be directly affected. The slurry line over the West Fork of the Stillwater River would have the potential to rupture. However, the slurry line's design would minimize the chances of a spill. Even if a spill occurred, fish would probably not be adversely affected. Population increases in the Stillwater Valley would lead to increased fishing pressure, possibly resulting in reduced fish populations or more conservative fishing regulations.

Impacts Unique to the Proposal and Alternatives 1, 2, 3, and 5

Neither the proposal nor alternatives, 1, 2, 3, or 5 would have any direct impact on fish in the Stillwater River or its tributaries. Population increases resulting from the mine operation, however, would lead to increased fishing. The magnitude of the increase cannot be accurately predicted. If the increased pressure is great enough, fish populations would be reduced.

Mitigating Measures

- o Monitoring game fish populations and fishing pressure would allow the Department of Fish, Wildlife, and Parks to determine if fishing regulations should be adjusted.

Impacts Unique to Alternatives 4 and 6

Impacts to the Stillwater River from alternatives 4 and 6 would be nearly identical to the proposal, except that a slurry line built over the West Fork of the Stillwater River would have the potential to rupture. The required slurry line would have two walls, spill containment ponds on either side of the stream, and a pressure sensor system to halt flow in case of rupture. Still, there is a remote possibility that the line could break over the West Fork. Slurry would then enter the stream and possibly the main river until halted by the sensor system. As a result, total suspended solids would temporarily increase.

The impact of the spilled slurry would depend on (1) the volume of slurry spilled, (2) flow level of the West Fork and main river, (3) duration of the spill, (4) time of year, and (5) existing levels of suspended solids in the streams. Although the exact effects cannot be predicted, major impacts on fish would not be expected. It is extremely unlikely that unfavorable environmental conditions would occur simultaneously with a long-duration, high-volume spill. Moreover, fish are able to tolerate relatively high concentrations of suspended solids for a limited time (Stroud, 1967).

Mitigating Measures

Game fish populations and fishing pressure could be monitored in alternatives 4 and 6 in the same way as in alternatives 1, 2, 3, and 5.

WILDLIFE

Summary of Impacts of the Proposal: Mining would disturb only previously developed lands and other noncritical wildlife habitats. Reclaimed lands would eventually furnish adequate wildlife habitat. Mule deer of the Bear-tooth range and bighorn sheep would lose a small amount of their wintering areas. These two species may also respond to mining activity and noises by withdrawing from areas nearby. The bighorn herd has some characteristics which may make it particularly vulnerable to nearby human activity. The Montana Department of Fish, Wildlife, and Parks (pers. com., August 5, 1982) believes that a herd reduction is imminent and that herd elimination is possible if mining is permitted. Further research would be required to confirm this position. Road kills of deer would increase due to mine-related traffic. Population increases in Stillwater County, of which only a portion would be caused by the mine, would increase housing construction, hunting and other recreation, and poaching by an unknown amount. The Montana Department of Fish, Wildlife, and Parks may respond to increased demand on the wildlife resources by establishing more conservative hunting regulations.

Summary of Impacts of Alternative 4: Only previously developed lands and other noncritical wildlife habitats would be destroyed at the minesite. The tailing pond would remove primarily stony grasslands, an important mule deer habitat. Habitat destruction and activities at the minesite would displace some mule deer of the Beartooth winter range. The tailing pond, located in the high-density Limestone winter range, would displace still more deer. Loss of bighorn winter range would be minimal. Reclaimed lands would eventually furnish adequate wildlife habitat. The bighorn herd has some characteristics which may make it particularly vulnerable to nearby human activities. The Montana Department of Fish, Wildlife, and Parks (pers. com., August 5, 1982) believes that a herd reduction is imminent and that herd elimination is possible if mining is permitted. Further research would be required to confirm this position. Road kills of deer would increase due to mine-related traffic. Population increases in Stillwater County, of which only a portion would be caused by the mine, would increase housing construction, hunting and other recreation, and poaching by an unknown amount. The Montana Department of Fish, Wildlife, and Parks may respond to increases demand on wildlife resources by establishing more conservative hunting regulations.

Impacts All Production Systems Have in Common

Impacts to wildlife can be classified as direct or indirect. Direct impacts from the proposed mine would include habitat loss and resulting displacement of wildlife, creation of different habitats during reclamation, destruction of relatively nonmobile populations, and disturbance of nearby wildlife due to mining activity and noise. Indirect impacts would include collisions between vehicles and wildlife (road kills) and demands on the environment (housing, hunting and other outdoor recreation, poaching) arising from increased human population.

The mule deer, elk, and bighorn sheep of the Stillwater winter ranges spend other seasons at considerable distances from the Stillwater Valley. Any substantial population changes occurring on the winter range would also be noticed at distant points. The amount and quality of winter range often determines population levels of big game species (Mautz, 1978). Winter energy expenditures exceeding the energy supplied by forage or body reserves affect animal health and reproduction. Developments causing disturbances of animals raise their energy cost of living, thus depleting energy otherwise available for growth and reproduction. Excessive disturbance can also increase adrenocorticoid levels in the blood, reduce birth weights, and cause absorption or abortion of embryos (Geist, 1971b).

Direct Impacts

Wildlife Habitats. Twenty-eight acres, or 36 percent, of the land that would be disturbed by production facilities consists of previously developed lands. Loss of this type would have little impact on wildlife. Some of the previously developed lands were revegetated in 1979. However, the presence of buildings, mining facilities, and pavement, combined with high levels of human activity, limit wildlife use. Mining would merely return revegetated lands to pre-1979 conditions.

Proposed mining would destroy 41 acres of the open Douglas-fir habitat (about 53 percent of lands covered by production facilities). Small amounts of disturbed forests, boulder and talus fields, and rock cliffs and benches are included in this acreage. While only mule deer, bighorn sheep, songbird, small mammal, and blue grouse use of open Douglas-fir forests has been documented, other species undoubtedly use this habitat. Loss of the 41 acres would probably not significantly affect wildlife. Displaced animals could move into the nearby and abundant Douglas-fir forest (table III-4) that would remain undisturbed. Mining would remove only 8 acres of other forested habitats. Loss of such a small acreage would not significantly affect wildlife populations.

The proposal and alternatives would destroy various amounts of wildlife habitats depending on the size and location of the tailing pond and associated topsoil stockpile (table IV-5). Over 90 percent of the production facilities disturbance could not be used by wildlife until it is reclaimed--at least 27 years after mining is initiated (table IV-4). The remainder would be revegetated at some point during mining. Revegetation would establish a ground cover primarily consisting of cool-season grasses. (See Vegetation.) These grasses, together with planted trees and shrubs, would eventually supply adequate habitat for most species. Habitat quality would probably increase over time as plant diversity increases and as woody plants mature. The revegetation of previously developed lands (the sites of buildings, ore stockpiles, pavement, etc.) would benefit wildlife.

Mule Deer. Mule deer inhabit roughly 33,000 acres of winter ranges in the upper Stillwater Valley (fig. III-12). Production facilities would remove less than 1 percent of this range. Impacts would be greatest on deer using the Beartooth winter range. The production structures would be centered within and cover about 3 percent of this winter range. The most important habitat loss would be 41 acres of open Douglas-fir forest. Deer would probably return after revegetation is complete.

The noise and activity of mining, especially during the construction phase, may displace nearby deer. If deer response to mining activity is similar to their response to roads, deer use would substantially decrease in all areas within 1/8 mile of mining (Rost and Bailey, 1974; Perry and Overly, 1977).

Mule deer displaced by mining activity or habitat loss would move into adjacent habitats. The quality of habitat they would encounter is unknown, as is the amount of additional competition for resources they would create. Population effects cannot be predicted.

TABLE IV-5

Wildlife Habitat Types Present in Proposed and
Alternative Disturbance Areas

Wildlife Habitat Types	Acres Disturbed Proposal	Estimated Acres Disturbed Alternatives ¹					
		1	2	3	4	5	6
Stony grassland	3	0	68	46	165	175	131
Sagebrush shrubland	0	0	0	0	13	15	11
Skunkbush shrubland	0	0	9	6	0	0	0
Drainage bottom meadow	0	0	0	0	0	0	0
Riparian woodland meadow	0	0	0	0	0	0	0
Ravine aspen	2	1	10	7	1	1	1
Open Douglas-fir forest ²	80	62	84	69	41	41	41
Closed coniferous forest ³	7	5	5	5	5	5	5
Subalpine forest ⁴	5	2	2	2	2	2	2
Disturbed grassland	0	0	0	0	0	0	0
Hay meadow	0	0	0	0	1	1	1
Previously developed ⁵	68	66	43	43	43	16	43
Water	0	0	0	0	0	0	0
TOTAL	165	136	221	178	271	256	235

Sources: Camp Dresser and McKee 1981; Stillwater Mining Company, 1984a.

¹Does not include acreage disturbed by slurry lines. Alternatives 2, 3, 4, and 6 include a 15-acre emergency tailing pond assumed to be located with the previously developed type at the minesite.

²This type includes small amounts of disturbed forest, boulder, and talus field, and rock cliffs and benches.

³Consisting of closed Douglas-fir forest, closed Douglas-fir/lodgepole pine forest, and closed lodgepole pine forest.

⁴This type is a vegetation type.

⁵Includes abandoned mine areas, roads, revegetated lands, and current disturbances related to Stillwater Mining Company's exploration operations.

White-tailed Deer. Production facilities would be built near white-tailed deer range along the Stillwater River. The only potential direct impact of mining would be displacement of deer due to mining noise and activity. The amount of displacement would not be great enough to cause a noticeable population decline.

Bighorn Sheep. Even without mining development, the Stillwater bighorn herd is in a precarious position. It is a small herd living on limited winter range. The herd's long history of population stability (table III-6), possibly resulting in an inability to vary reproduction (development of maintenance phenotypes), could be predisposing this herd to a decline (Geist, 1982). Bighorn herds unable to adjust reproduction that live on small patches

of habitat within timbered areas may be especially susceptible. In addition, the herd may be inbred (chapter III) and therefore unable to respond to changing environmental conditions. Inbreeding can also limit productivity.

A definitive cause-and-effect relationship between historic mining activities and bighorn population fluctuations has not been demonstrated. Youmans et al. (1982) related the 1950s Stillwater bighorn herd decline to mining. Stoneberg (1977) stated that mining did not directly reduce the herd, but may have contributed to a gradual decline. Stewart (1984) believes that mining exploration is probably responsible for recent declines in lamb production. However, the herd has exhibited an overall, long-term population stability despite historic disturbances related to mining (table III-6). No population decline was noted for the 1940s, when a town capable of housing 2,000 people existed near Mountain View Lake (Stoneberg, 1977). Stoneberg (1977) correctly predicted that the herd size would remain at about 50 animals.

Production facilities would be located on the northern portion of the 1,920-acre primary winter range (fig. III-13) and destroy roughly 61 acres of the range. Loss of this range would have negligible effects on bighorn. Although bighorns now use some revegetated areas, much of the disturbance area is marginal habitat due to the long distances to escape cover, high levels of human activity, and presence of buildings and ore stockpiles. Youmans et al. (1982) agree that the effect of range loss would be minor.

Mining activity and noise may disturb bighorn occupying adjacent range. Effects would be greatest during the initial construction phase. Bighorns would be susceptible to the adverse affects of disturbance previously noted for other big game animals (Geist, 1971a, 1971b). Disturbance is likely to be least detrimental to vigorous, healthy individuals living in large populations (Geist, 1971b). The small Stillwater herd would therefore be particularly sensitive to disturbance.

Bighorns may respond to mining activity by withdrawing to the south. The precise distance of the withdrawal cannot be predicted. However, it may be only to the south side of the cliff behind Stillwater Mining Company's headquarters. The cliff would form a visual barrier between mining and remaining winter range. Visual barriers may have allowed other Montana bighorns to remain at a lambing ground despite nearby seismic activity (Andryk, 1983). The cliff would also reduce noise levels to below the 46 dB(A) predicted for FAS 419. (See Aesthetics, table IV-17). These levels would have little impact on bighorn. Reynolds (1974) found that Dall's sheep did not show significant responses to a compressor producing 58 to 73 dB(A).

Mine-related traffic would probably not cause significant disturbance to the bighorn. Large traffic increases are not expected on FAS 419 south of the mine (The road runs through the eastern part of the primary winter range.) Also, bighorn often use areas near roads and can become accustomed to traffic (Spalding and Bone, 1969; Ferrier, 1976; Horejsi, 1976; Risenhoover and Bailey, 1980). Behavioral and heart rate responses to traffic have been shown to be minimal (MacArthur et al., 1979; MacArthur et al., 1982). Bighorn, however, would be disturbed if drivers leave their cars and enter the winter range. Humans, especially when accompanied by dogs or when persistently

following sheep, can adversely affect sheep (Horejsi, 1976; Bear, 1979; Stevens, 1982; MacArthur et al., 1982; Stemp, 1982).

Youmans et al. (1982) and Stewart (1984) believe that bighorn ewes are increasing their home ranges and the herd is using less favorable foraging areas. Youmans and Stewart attribute these changes to human activities and traffic increases related to mining. The subsequent decrease in energy and nutrients available for reproduction would reduce lamb production. The Montana Department of Fish, Wildlife, and Parks (pers. com., August 5, 1982) believes that there is a "small but very real chance" for herd elimination and that "a reduction in herd numbers is imminent" if mining is permitted. Due to the sensitive nature of the Stillwater herd, the Montana Department of State Lands agrees that increased human activities could potentially affect the bighorn population. However, further monitoring and research are required to test hypotheses proposed by Youmans et al. (1982) and Stewart (1984). Research should include (1) larger sample sizes, (2) documentation of mining and other human activities, and (3) thorough analyses of other factors affecting the population, such as weather, hunting, predation, inbreeding, and intra-specific stress.

If the herd is eliminated, natural reestablishment would be highly unlikely. However, the mixing of Stillwater rams with sheep from other herds (Stoneberg, 1977) creates a potential for natural reestablishment.

Elk. Production facilities are not included within any elk winter ranges. The nearest ranges, the Main Stillwater and Horseman Flats, are approximately 1/2 mile to the north. Studies by Ward (1976) and Perry and Overly (1974) suggest that 1/2 mile is a sufficient distance to prevent disturbance effects on elk. In addition, the Main Stillwater and Horseman Flats winter ranges receive only limited use when compared to the Picket Pin and Lodgepole ranges.

Other Big Game Species. Facilities for production are probably within black bear spring habitat. Bears would therefore lose some habitat during mine construction and operation. Some bears may leave the area. However, if mine garbage disposal is careless, other bears may be attracted. This would increase the chances for bear/human confrontations. Mountain lions would lose a small amount of habitat, but may continue to hunt near mining facilities. Russell (1978) has noted that hunting activities are not necessarily remote from human habitation. After replanted vegetation matures, well after mine closure, suitable bear and lion habitat would again be available. Mining would not affect moose or mountain goats.

Small and Medium-Sized Mammals. Small mammal populations would be eliminated or displaced by mining. Deer mice would be most affected, losing 41 acres of Douglas-fir forest (table III-4). The straw mulch and grasses used during reclamation (see Vegetation) would attract small mammals and allow repopulation of the disturbance area (Stockeler and Slabaugh, 1965; N. Stark, University of Montana, pers. com., July 12, 1984). Medium-sized mammals, such as coyotes and snowshoe hares, would be displaced from disturbance areas. Overall population impacts would not be noticeable and reclaimed areas would eventually supply suitable habitat.

Birds and Reptiles. Mining would make the golden eagle nest site near Stillwater Mining Company's headquarters unusable. Snow (1973) and Call (1979) suggest that high levels of human activity near eagle nests prevent successful nesting. This impact would be insignificant, since the nest has not been active since 1980. Hunting habitat for golden eagles and other raptors would be slightly reduced while the mine operates. The design of the on-site transmission line would follow guidelines suggested by Olendorff et al. (1981) to avoid raptor electrocutions.

Songbirds would leave disturbance areas until revegetation has created sufficient cover. Forest songbirds, such as mountain chickadees and evening grosbeaks, would be the most affected birds. Planted trees would supply adequate cover only after several years.

Blue grouse would move from disturbance areas as mining begins. The adjacent, undisturbed forest would probably supply adequate habitat. Revegetated areas would eventually provide suitable cover for grouse. Mining would not affect waterfowl populations and only a few reptiles would be killed or displaced.

Indirect Impacts

Road Kills. Mining would increase traffic on FAS 419, FAS 420, and FAP 78 (see Transportation), resulting in a noticeable increase in road kills. Employees commuting to the mine would create most of the traffic on FAS 419. Specific predictions are unavailable for the road south of the minesite serving the Beartooth Ranch and Woodbine Campground. However, traffic increases on this road segment would probably be much smaller than any increases to the north.

Deer would account for most of the increase in road kills. In 1980, 23 mule deer and one white-tailed deer road kills were documented. Total kill was probably much higher (Youmans et al., 1982). Generally, the chances of collisions with mule deer would increase as traffic and deer densities increase. An estimated 4 miles of FAS 419 near Twin Buttes Schools may therefore account for the most mule deer kills. (This road segment borders aerial survey units 1, 5, and 6; see table III-5). The slightly increased traffic on FAS 420 would encounter high densities of mule deer from Beehive to Nye. (This segment is between aerial survey units 1 and 7; see table III-5.) However, road kills could occur anywhere along road with increased traffic. Stretches passing through dense vegetative cover or alfalfa fields would prove especially hazardous. In addition, Youmans et al. (1982) identified four major white-tailed deer crossing areas along FAS 419 and one major crossing on FAS 420 (fig. III-12). Vehicles traveling through the crossings would undoubtedly kill some whitetails. Projected traffic increases would not be great enough to reduce deer use of habitat adjoining FAS 419. Carbaugh et al. (1975) found that traffic volume was not correlated with observations of whitetails.

Vehicle collisions with elk would be rare. Elk winter ranges and migration routes lie northwest of FAS 419. Some bighorns, crossing the road to

reach peripheral winter range (fig. III-13) or meadows along the Stillwater River (Stoneberg, 1977) could be struck by vehicles. Road kills, however, would not contribute substantially to overall herd mortality. Large traffic increases are not predicted. Since nocturnal activity by bighorn is minimal during winter (Geist, 1971a; Risenhoover and Bailey, 1980) bighorns would not be crossing the road when collisions are most likely.

Although all other wildlife species crossing major, paved roads would be exposed to greater chances for road kills, measurable population effects are not anticipated. The most noticeably affected wildlife may be raptors, especially golden eagles, hit while feeding on carrion on the road. Road kills on mine roads would be insignificant due to warning signs and the low speeds of mine vehicles.

Housing Construction. The amount of wildlife habitat lost to mine-related housing development would be minimal. About 41 acres of housing development would be required. (See Sociology and Land Use.) About 80 percent of the acreage would be in or adjacent to Columbus or Absarokee (J. Beaudry, Stillwater County, pers. com., December 26, 1984). Only 8 acres would occur within the wildlife study areas. Development of this small acreage could occur in any of the county-approved subdivision sites.

Several subdivision sites are located within mule deer and white-tailed deer ranges. The already-developed Cathedral Mountain subdivision lies within the main Stillwater elk winter range and the Rainbow Ranch site slightly overlaps the bighorn peripheral winter range. Housing construction, unrelated to Stillwater Mining Company's proposal, could occur on these sites. Demand for housing would arise from population increases in southeast and southcentral Montana. Subdivisions could remove some habitat and related activities could disturb big game. Deer would be the most negatively affected species. The magnitude of the impacts cannot be predicted due to the lack of information on future housing construction. Elk would not lose additional habitat. Adequate buffers between development and elk range would keep disturbance effects to a minimum. Habitat loss and disturbance effects on the few bighorn using the peripheral ranges would not affect the total bighorn population.

Hunting. Even without the mine, demand for hunting is expected to increase in the Stillwater Valley. The mine, however, would increase the county's population (see Sociology) and further raise hunting demands. Actual hunting levels would be determined by Montana Department of Fish, Wildlife, and Parks regulations. Future hunting increases in the Stillwater Valley cannot be predicted. Hunting would not affect wildlife living near the production facilities. Stillwater Mining Company would prohibit its employees from carrying firearms. The company would also follow U.S. Forest Service guidelines on road closures during hunting seasons.

Deer hunting generates recreational and economic benefits in the Stillwater Valley. Deer ranges lie within Montana Department of Fish, Wildlife, and Parks hunting districts 520 and 572. In 1980, over 1,700 rifle hunters harvested nearly 800 deer from both districts. These hunters added an unknown amount of money to the county's economy. Some hunters probably employed the

three professional guides in Stillwater County. Should the Department of Fish, Wildlife, and Parks determine that deer harvest is excessive, strict regulations may be enacted. This would limit hunting opportunity and decrease economic benefits.

Demand for bighorn hunting may increase. However, the Department of Fish, Wildlife, and Parks allows only a predetermined quota of rams to be harvested. Although no Stillwater rams were killed during the 1983 regular season, two permits were issued and filled during a late-season hunt. The level of harvest would continue to be regulated by the Department of Fish, Wildlife, and Parks.

Elk hunting would also increase in response to increased human population. Youmans et al. (1982) state that hunting pressure is already considerable. Landowners currently in conflict with elk may desire even more hunting. Bull harvest is open to all permit holders, while cow harvest is regulated by limited permit sales. Annual harvest by rifle hunters generally ranges from 10 to 20 animals with a very low success rate for bull hunters. The Department of Fish, Wildlife, and Parks would continue to regulate the harvest. If bull hunting becomes excessive, the Montana Department of Fish, Wildlife, and Parks could institute a quota or a limited-permit system (Youmans et al., 1982; Montana Department of Fish, Wildlife, and Parks, pers. com. August 5, 1982). This would decrease hunting opportunities, especially for non-residents. Professional guides in Stillwater County would lose substantial amounts of income.

If hunting of black bears increases and harms the bear population, the Department of Fish, Wildlife, and Parks (pers. com., August 5, 1984) could close seasons. Reducing or eliminating bear season would create an adverse, although insignificant, impact on Stillwater County's economy. Although mountain lions would also be hunted more frequently, the amount of hunting and resulting impacts cannot be predicted. Populations of small game species would not be limited by increased hunting.

Other Recreation. Mine-related population increases would lead to more recreation activities (such as snowmobiling, hiking, camping, four-wheel-driving) on big game winter ranges. This increase would be added to the growth forecasted without the mine (table III-21). The locations and extent of total recreational increase are unknown. Therefore, precise predictions of effects on wildlife cannot be made. High levels of snowmobiling, anticipated for the Picket Pin and Lodgepole elk ranges (Youmans et al., 1982), could cause disturbance effects on elk and result in a distributional shift. The time that recreationists would spend on bighorn winter range cannot be predicted. However, even low levels of human activity could adversely affect bighorn.

Poaching. Some poachers would be included in the influx of people to Stillwater County. Their numbers cannot be predicted. All wildlife, especially big game, would be subject to poaching. Remote areas with nominal road access may receive the most poaching. Poachers would probably operate only infrequently near areas of human activity, such as FAS 419. This may help to protect the white-tailed deer and bighorn populations. High visibility of law

enforcement officers and strict enforcement of game laws would also reduce poaching. Stillwater Mining Company would discourage poaching by prohibiting firearms on the permit area.

Mitigating Measures

The impacts of the proposal and all alternatives could be mitigated by the following measures.

- o Monitoring of big game distributions and population characteristics would allow impacts of mining to be more rapidly detected. Management responses and mitigating measures could then be developed. The Beartooth mule deer herd and the bighorn herd would be most affected by mining and deserve the closest attention. Continuing research into bighorn ecology, started by Youmans et al. (1982) and Stewart (1975; 1984), would help to detect mining impacts.
- o Disturbance effects on bighorn would be reduced by limiting human activity on their winter range. Closing 4-wheel drive or truck roads within or adjacent to winter range would be beneficial. Educating mine employees about the adverse effects of disturbance and placing interpretive signs along FAS 419 would also help to reduce impacts.
- o Limiting major construction to periods when bighorn are off the winter ranges (approximately June 1 to October 15) would reduce disturbance effects.
- o Habitat improvement (such as fertilization or prescribed burning) and transplanting would help to make the bighorn herd's future more secure. The first step in habitat improvement would be forage analysis and determination of range trend. Although merely enlarging the range would probably be beneficial, documented responses of both forage and bighorn to habitat manipulation would demonstrate the benefits. Transplanting unrelated bighorn would improve the herd's genetic diversity and subsequent environmental adaptability. Habitat analysis would first be necessary to determine if the range can support additional animals.
- o Road kills of deer would be reduced by the following methods: (1) car pooling and/or busing of mine employees, (2) posting deer crossing warning signs, (3) enforcing lowered speed limits in problem areas, (4) redirecting deer movements in problem areas by fencing, constructing underpasses, or using other methods (such as redesigning road segments).
- o Poaching and wildlife harassment by mine employees would be lowered if Stillwater Mining Company's policy specified disciplinary action against violators.
- o Discouraging construction on subdivisions within deer range would limit disturbance effects and habitat loss.
- o Monitoring snowmobiling and resulting reactions of elk would help to develop better management. This may be especially important on the Picket Pin and Lodgepole winter ranges.

IV-40 / Wildlife

- o If elk and deer are being over-harvested, closing roads into concentration areas would bring harvest levels down.
- o A conservation easement applied to the Beartooth Ranch would reduce the potential for further impacts on bighorn and mule deer. The easement would assure that the land use remained agricultural. Another conservation easement on the Picket Pin Ranch would partially compensate for impacts to deer and elk. Continuing agricultural uses and rejuvenating existing alfalfa fields would provide big game foraging areas. Stillwater Mining Company could consult with the Department of Fish, Wildlife, and Parks for specific management recommendations for each easement.

Impacts Unique to the Proposal

The tailing pond and associated topsoil stockpile would cover 88 acres of wildlife habitats within the permit area. The proportion of habitats destroyed by the tailing pond would be similar to those destroyed by the tailing pond and production facilities combined (table IV-5). Most (73 percent) of wildlife habitats could not be used by wildlife until revegetation is completed.

The proposal would remove about 7 percent of the Beartooth mule deer range. The most important habitat loss would be 80 acres of open Douglas-fir forest. Roughly 140 acres, or 7 percent, of the primary bighorn winter range would be destroyed. Noise and activity created by tailing pond construction would be added to that produced by production facilities construction. Raising the dam would also create noise and activity at 4- or 5-year intervals during the 3- to 4-month construction period. Adverse effects on deer and bighorn may be increased.

Impacts Unique to Alternative 1

Effects on wildlife populations in alternative 1 would be essentially the same as with the proposal. Although less land would be removed by the 53-acre tailing pond and 6-acre stockpile, much of this land has limited wildlife use. The amount of bighorn and mule deer (Beartooth herd) ranges lost would be only 1 percent less than the amount lost to proposed mining.

Impacts Unique to Alternative 2

This alternative's tailing pond and stockpile would destroy 129 acres of wildlife habitat, 41 more acres than would the proposal. Additional habitat would be disturbed by the 2-mile slurry line. However, locating the pond at the Stratton Ranch site would reduce impacts on mule deer and bighorn. The pond site lies between the Keogh and Beartooth mule deer ranges and is over 1 mile from bighorn range. Effects on bighorn would be somewhat lowered due to the absence of nearby dam construction. The Stratton Ranch pond site borders the main Stillwater elk range and, therefore, its construction could disturb elk. Overall impact to elk would be minor because of the limited elk use of the main Stillwater range. Impacts on all other wildlife species would be similar to those of the proposal.

Impacts Unique to Alternative 3

This alternative would destroy 86 acres of wildlife habitats at the Stratton Ranch site. Slightly more habitat would be disturbed than under the proposal. However, as in alternative 2, less impact on mule deer and bighorn would be expected. Impacts to elk and all other wildlife species would be similar to those of the proposal.

Impacts Unique to Alternative 4

The Hertzler Ranch tailing pond and stockpile would disturb about 179 acres of wildlife habitats, 91 acres more than the proposal. A 6-mile slurry line would also remove some habitat. Locating the pond at the Hertzler Ranch would increase impacts on mule deer. The pond would cover mostly stony grasslands and about one acre of hay meadow. Both these habitats are more important to mule deer than the predominant habitats of the proposed tailing site. Also, deer densities are much higher at the Hertzler site. (The Hertzler site is within survey unit 7 and the proposed site is within unit 2; see table III-5.) Bighorn would be somewhat less affected by building the pond at the Hertzler site. They would not lose any range to the pond. There would be slightly less disturbance effects due to the absence of nearby dam construction. Effects on elk and other wildlife would be similar to the proposal's effects.

Mitigating Measure

Monitoring of deer distributions and population characteristics would allow impacts of mining to be more rapidly detected. Management responses and mitigating measures could then be developed.

Impacts Unique to Alternative 5

Placing both tailing pond and mill at the Hertzler site would have a more adverse effect on deer than would the proposal and other alternatives. The mill would remove 12 more acres of habitat than alternative 4 (both would remove significantly more than the proposal). Mill construction and operation may affect nearby mule deer. The trucks used for ore transport would increase road kills of deer between the mill and minesite. Whitetail kills would probably be greatest at identified crossing areas (fig. III-12). This would be partly offset by the absence of mill workers driving from Nye to the minesite on FAS 419. Locating the tailing pond and mill at the Hertzler site would lessen disturbance effects of bighorn. Some marginal bighorn range would be saved. Effects on elk and other wildlife would be similar to those of the proposal.

Mitigating Measure

Monitoring, as in alternative 4, would help to detect the impacts on deer.

Impacts Unique to Alternative 6

This alternative would destroy 143 acres of wildlife habitats at the Hertzler site and require 6 miles of slurry line. Adverse effects on mule deer would be greater than the proposal's effects. Stony grasslands and a one acre of hay meadow, both important to mule deer, would be covered by the pond. Also, densities of deer are higher at the Hertzler site. Alternative 6 would, however, disturb less mule deer habitat than would alternatives 4 and 5. Bighorn would be less adversely affected than if mining proceeds as proposed. The bighorn would not lose marginal range. Bighorn would not be exposed to disturbance effects due to dam construction. Effects of alternative 6 and effects of the proposal on elk and other wildlife would be similar.

Mitigating Measure

Monitoring, as in alternatives 4 and 5, would help to detect the impacts of on deer.

THREATENED AND ENDANGERED SPECIES

Summary of Impacts of the Proposal and Alternative 4: No threatened or endangered plants or animals would be affected by the project.

Impacts All Production Systems Have in Common

The increased traffic on FAS 419 is expected to increase the incidence of wildlife road kills. Bald eagles attracted to carrion along roadsides could be hit by commuting workers and recreational motorists. Bald eagles could also be shot at by passing motorists. The effect that increased traffic and harassment would have on the bald eagle population is unknown, although it would probably be minor.

Activity levels at the mine, especially during shift changes and peak construction, may discourage bald eagles from feeding along approximately a half mile of the Stillwater River next to the mine. Bald eagle feeding habitat lies within 1/4 mile of the minesite. The importance of this river reach to bald eagles is unknown, although the project could decrease suitability of this stretch of river as feeding habitat for bald eagles.

Mountain ladyslipper, the only threatened and endangered plant species identified in the study area, was not found in the proposed permit area or alternative tailing pond locations; therefore, no impacts are anticipated.

Mitigating Measures

Commuter bus service, described as a mitigation measure in other sections, would help reduce the risk of bald eagle road kills and would decrease the

potential for disturbance of feeding habitat near the minesite. Road kills could further be reduced by removing animal carcasses from FAS 419.

Restricting construction to avoid periods of bald eagle use (October to April) would prevent conflicts with bald eagles.

Impacts Unique to the Proposal and Alternative 1

Each time the tailing dam is raised, construction activity might further interfere with the use by bald eagles of 1/2 mile of feeding habitat next to the mine.

Mitigating Measures

Restricting dam-raising construction to avoid periods of bald eagle use (October to April) would prevent conflicts.

Impacts Unique to Alternatives 2 and 3

The tailing pond at Stratton Ranch would be constructed within 1/2 mile of a bald eagle roosting area and next to potential nesting habitat. Although nesting of bald eagles in the Stillwater drainage has not been documented, roosting and potential use of suitable nesting habitat could be discouraged, especially during periods of dam construction

Mitigating Measures

Seasonal restriction of construction activities to avoid conflict with periods of bald eagle use would mitigate the impact of construction activity.

Impacts Unique to Alternatives 4 and 6

The tailing dam at the Hertzler site would disturb less than 2 percent of potential hunting habitat used by peregrine falcons and bald eagles. The amount of a habitat affected would have negligible effect on the area's ability to support bald eagles and peregrine falcons.

The tailing dam, because of its distance to the West Fork of the Stillwater, would have no effect on use of potential nesting habitat by bald eagles. The peregrine falcon cliff complex would be unaffected by the operation of the tailing pond.

Mitigating Measure

Scheduling heavy equipment activities within 1/2 mile of the cliff complex during periods other than the nest selection period of March 1 through April 30 would avoid conflict with potential use of the cliff by peregrine falcons.

Impacts Unique to Alternative 5

The U.S. Forest Service has identified historic nesting habitat for peregrine falcons on a cliff complex near the Hertzler mill and tailing disposal site. The haul route that would be used to truck ore to Hertzler would cross within 1/4 mile of the cliff complex. The haul road and activity on it might prompt nest abandonment or discourage peregrines from selecting nest sites on the cliff complex (U.S. Department of Agriculture, Forest Service, 1982).

Mitigating Measures

- o Relocating the haul road about three-quarters of a mile to the east of the cliff complex would reduce the noise and activity at the peregrine falcon nest site. The relocation would require purchase of some private land.
- o Scheduling heavy equipment activities within 1/2 mile of the cliff complex during periods other than the nest selection period of March 1 through April 30 would avoid conflict with potential use of the cliff by peregrine falcons.
- o Deferring construction activities that are within one-half mile of the nest(s) and that generate loud noises until after fledging in June or July would reduce disturbance to the nesting sites.

CLIMATE

The small amount of particulate emitted from ground level sources during mining and milling would not affect the climate of the area.

AIR QUALITY

Summary of Impacts of the Proposal and Alternative 4: Particulate matter would be the only pollutant emitted in significant quantities by activities associated with the proposed project. Even so, particulate emissions would be minor. Modeling results indicate that the annual average TSP (total suspended particulate)₃ concentrations would increase by a maximum of 3 $\mu\text{g}/\text{m}^3$ (micrograms per cubic meter) and 24-hour₃ TSP concentrations would increase by a maximum of 16 $\mu\text{g}/\text{m}^3$. Wind erosion of disturbed areas during construction activities would also be a potential, but temporary, source of particulate.

Summary of Impacts of Alternative 4: Particulate matter would be the only pollutant emitted in significant quantities. Even so, particulate emissions would be minor. Modeling results indicate that the annual average TSP (total suspended particulate)₃ concentrations would increase by a maximum of 3 $\mu\text{g}/\text{m}^3$ and 24-hour TSP₃ concentrations would increase by a maximum of 16 $\mu\text{g}/\text{m}^3$. Wind

erosion of disturbed areas during construction activities would also be a potential, but temporary, source of particulate.

Impacts All Production Systems Have in Common

Particulate emissions from the mining and milling operations would be minor. Total emissions would be about 29 tons per year (table IV-6). The major source would be vehicle traffic, accounting for 14 tons per year, or nearly 50 percent of all emissions. Ventilation exhaust would emit 7 tons per year, or 25 percent of the total emissions. The crushing and conveying system would be enclosed, and exposed areas would be revegetated. Hence, these sources would emit only a small amount of particulate (table IV-6). SMC would maintain standing water over the tailing pond. Therefore, no dust would be emitted from the pond.

Camp Dresser and McKee (CDM, 1984) used the EPA VALLEY model to predict total suspended particulate (TSP) concentrations near the mine. Using a

TABLE IV-6

Inventory of Emission Sources

Source	Total Emitted TSP in Tons/Year
Ventilation Exhaust	7.2
Dump Waste Rock	0.1
Coarse Ore Stockpile	0.1
Waste Rock Storage	0.3
Tailing Embankment	0.7
Apron Feeders Both Levels	0.2
Dump Coarse Ore Storage	0.2
Conveyor to SAG Mill	0.1
54-inch Conveyor	0.1
Ore and Waste Loading - 5,000 Level	1.8
Grizzly Both Levels	0.7
Train Dumps Both Levels	0.1
Waste Loading - 5,150	0.6
Topsoil Storage Pile	0.1
Waste Rock and Hauling from 5,000 Level	1.4
Vehicle Traffic	14.0
Coarse Ore Storage	0.1
Thermal Dryer ^a	1.3
TOTAL	29.1

Source: CDM, August, 1984.

^aPoint Source

IV-46 / Air Quality

production rate of 1,000 tons of ore per day, and local meteorological data, the annual average TSP concentration was predicted to increase by $3 \mu\text{g}/\text{m}^3$. When added to the background TSP concentrations of $14 \mu\text{g}/\text{m}^3$, the total annual average TSP concentration of $17 \mu\text{g}/\text{m}^3$ would be only 23 percent of the Montana Ambient Air Quality Standard (MAAQS) of $75 \mu\text{g}/\text{m}^3$.

The maximum increase in the 24-hour TSP concentration was predicted to be $16 \mu\text{g}/\text{m}^3$ (CDM, 1984). When added to the maximum background 24-hour concentration of $41 \mu\text{g}/\text{m}^3$ measured at the minesite, a total of $57 \mu\text{g}/\text{m}^3$ can be expected. This would be only 28.5 percent of the Montana AAQS of $200 \mu\text{g}/\text{m}^3$.

Ore concentrate would be stored in sealed containers and trucked to Columbus for shipment by rail to various markets. No concentrate particulate would be emitted during hauling to Columbus.

The presence of potential mutagens and carcinogens in the ore and concentrate was of major concern to the Montana Air Quality Bureau (AQB). However, the evaluation of potential emissions from mining and milling activities indicates that the particulate concentrations would be low. The AQB therefore determined that adverse health impacts would probably not occur (H. Robbins, Chief, AQB, written com., March 1982). Other research shows that the miners' health probably would not be adversely affected (National Research Council, 1977).

During the construction of the mill and mine complexes, disturbed areas might be eroded during high winds. This would be temporary only and is not anticipated to affect average TSP concentrations.

Impacts Unique to the Proposal and Alternatives 1, 2, 3, 4, and 6

The proposal and alternatives 1, 2, 3, 4, and 6 would cause no unique effects on air quality.

Impacts Unique to Alternative 5

Alternative 5 would increase annual average TSP concentrations at the Hertzler mill site by a maximum of $5 \mu\text{g}/\text{m}^3$ (Anaconda Minerals Company, 1982). This increase would be minor. Haul truck traffic between the mine and mill would be the major source, emitting 18.5 tons of particulate annually. The residents living next to FAS 419 and FAS 420 between the mine and mill may be exposed to somewhat higher TSP concentrations. This increase in dust and the higher noise levels may annoy some residents.

Mitigating Measures

If dust off of loaded ore in the ore trucks were to become a problem the Forest Service would require the trucks to be covered.

EMPLOYMENT AND INCOME

Summary of Impacts of the Proposal and Alternative 4: The proposal and all alternatives would have the same impact. The project would provide an additional 223 permanent jobs in Stillwater County, of which approximately 89 would be filled by local residents. Annual wages paid at the mine would range from \$14,500 to \$50,000.

Employment

Construction of the project would last two years. During the first year, employment would range from 100 to 250 employees (Stillwater Mining Company, 1984a, p. 3.1-7), for an annual average of 230 jobs (Stillwater Mining Company, 1984a, p. 6). During the second year, employment would peak at 320 jobs (Stillwater Mining Company, 1983, p. 3.1-7). (See fig. IV-1.)

When the mine and mill are at full production, Stillwater Mining Company would employ 223 persons: 25 administrative staff, 155 mine workers, 25 mill workers, and 18 workers to fill positions vacated due to illness, absenteeism, and sick leave time (Stillwater Mining Company, 1984b, p. 8a). In addition, 45 temporary workers would be hired for three to four months in years 2, 5, 9, 14, and 21 to raise the tailing pond embankment (Stillwater Mining Company, 1984c, p. 8a).

The 223 permanent jobs represent a 10.3-percent increase over the total number of jobs in Stillwater County in 1982. Of these new permanent jobs, 54 percent, or 120 jobs, are expected to be filled by persons moving into Stillwater County. Approximately 40 percent, or 89 positions are expected to be filled by Stillwater County residents (Stillwater Mining Company, 1984b, p. 8). The balance of the jobs are expected to be filled by persons who commute from outside the county.

Approximately 50 percent of the construction-phase jobs are expected to be filled by local residents and 50 percent are expected to be filled by persons who commute or move into the county (Stillwater Mining Company, 1984b, p. 6). A number of construction-phase positions would be continued as permanent positions.

Local government and business employment could increase by approximately 83 jobs due to increased mining employment. These jobs most likely would be filled by local residents (Stillwater Mining Company, 1984b, p. 6).

Permanent closure of the project, whether after the scheduled 30 years or earlier, would shrink the employment base to what it would have been if the mine had never existed. Persons laid off from the operation would--

- o Leave the area seeking employment.
- o Remain in the county and commute to jobs outside the area.
- o Remain in the county and take early retirement (if they have worked long enough for the company).
- o Remain in the county and compete for other jobs in the county.

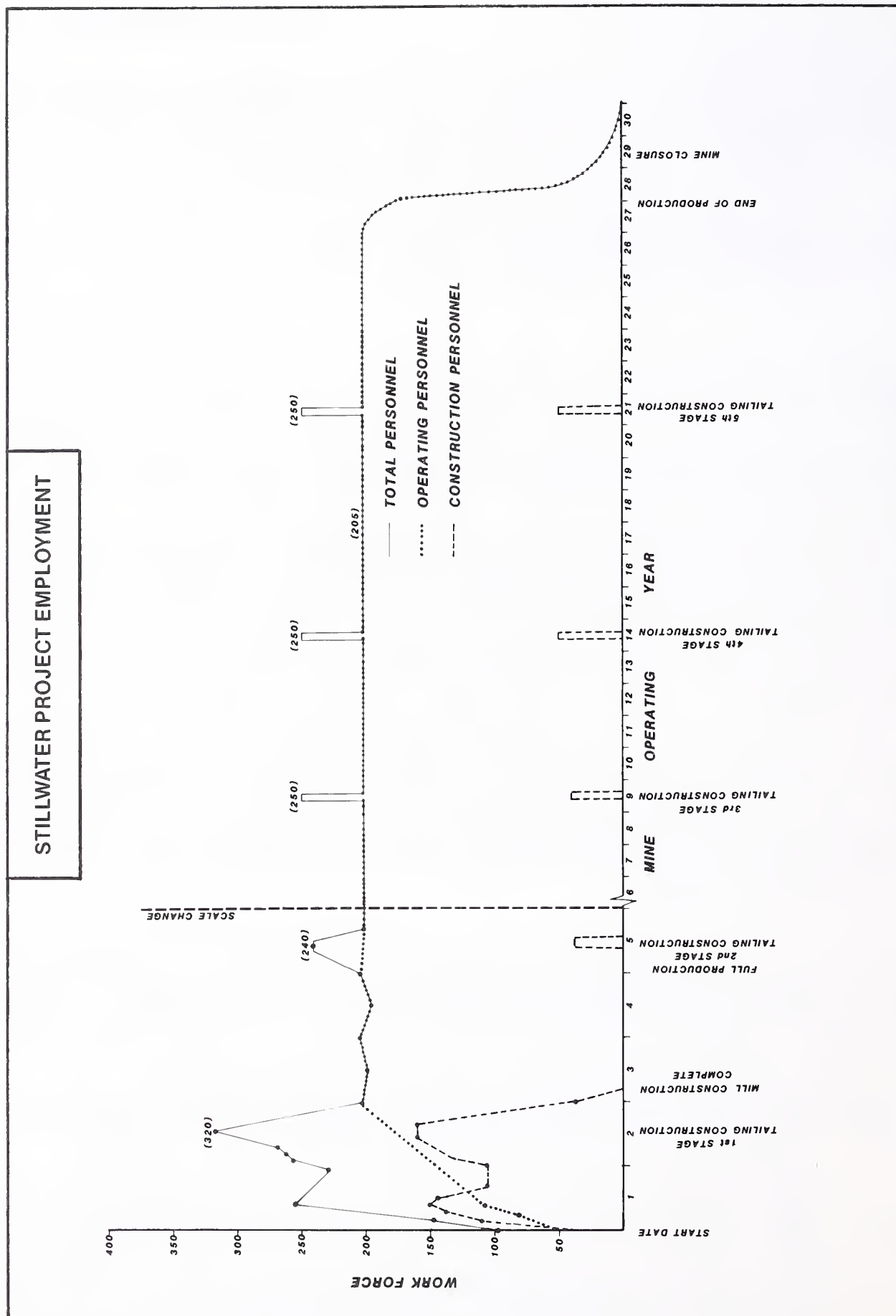


FIGURE IV-1

Although the work force for the project would in most years total 205 workers, the company would employ as many as 320 during the initial construction years and 250 each time the tailing dam is raised. Eighteen additional jobs would be added each year as positions are vacated due to illness, absenteeism, and sick leave.

A temporary closure would have an impact directly related to the length of the closure. If the closure were short, less than six months, only the mine workers themselves would be affected. If the closure were to last long enough, the impact would approach that of a permanent closure.

Income

Annual wages of mine and mill employees would range from \$14,500 for secretarial positions to \$50,000 for management positions (Les Darling, Stillwater Mining Company, pers. com., Dec. 18, 1984). In 1981, three-fourths of the respondents to a county survey reported annual gross incomes below \$24,000 (Entercom, 1981, p. 4-15). Average annual wages paid at the mine could range from \$22,669 to \$26,310.

An early closure of the project would have essentially the same impact on income as the scheduled closure of the project. The wages and salaries paid by the company would cease and per capita income would go down. To the extent that the laid-off mine workers were able to remain in the area and commute to other jobs or take early retirement, the decline in income would be reduced.

A temporary closure would have an impact directly related to the length and cause of the closure. If the closure lasted long enough, its impact would approach that of a permanent closure. To the extent that unemployment benefits would be available to workers, the income loss would be reduced.

Ordinarily, the additional payroll provided by the project would dampen the effect of year-to-year variations in agricultural income. However, should the payroll be interrupted during a poor agricultural year, the instability in total personal income would be intensified.

Impacts of Extended Mine Life

The impact on county income and employment of a project life longer than 30 years would depend on the level of mine employment. If mine employment remains at the same level as the 30-year plan, employment and income impacts would be the same as for the 30-year plan. If mine employment declines, county employment and income would fall. If mine employment increases in a 30-year (or longer) mine life, county income and employment would increase.

SOCIOLOGY

Summary of Impacts of the Proposal and Alternative 4: The proposal would increase the population of Absarokee and Nye by as much as 25 percent. In turn, the number of mining jobs held by Absarokee residents would make up a large proportion of all jobs. Some current Absarokee residents would have less influence over community matters.

Population increases stemming from mine development would add an additional 510 persons to Stillwater County. These increases would amount to 8.1 percent of the population projected for Stillwater County in 1990 without the Stillwater Project, and 7.8 percent in 1995. The population of Absarokee is projected to increase by 220 persons by 1995. This increase would amount to a 24.7-percent rise above the 1995 level without the mine. The population of Columbus is projected to increase by 190 persons, a rise of 10.3 percent above the 1995 level without the mine.

Impacts All Alternatives Have in Common

Demography

The additional population added by the Stillwater Project would be distributed throughout Stillwater County (table IV-7). Eighty percent of the 120 in-migrating mine workers are expected to be married and have three dependents each. Total direct mine-related in-migration is expected to be 408 persons (Stillwater Mining Company, 1984c, p. 8a). Some additional employment in-migration is also expected; however, it will be minor. Approximately 45 persons may in-migrate to Stillwater County to fill jobs created by mine-induced employment growth and to fill jobs vacated by local residents who go to work for the mine. Teachers and police officers would be examples of the latter. Forty-six percent of the 45 in-migrants are expected to be married and have 2.5 dependents each for a total secondary in-migrating population of 97 (Stillwater Mining Company, 1984c, p. 8a). Total in-migrating population due to the Stillwater Project is expected to be 505 to 510 persons.

The distribution of in-migrants would depend on housing availability within commuting distance of the mine, and personal preferences for different community amenities. Table IV-8 shows the expected distribution of in-migrating persons throughout Stillwater County. It should be noted that in-migrants may not settle in the anticipated patterns. Some could choose to live closer to the mine, increasing the number in the Nye-Fishtail area, rural areas outside Absarokee, and Absarokee.

The population of Absarokee is expected to grow the most--27.8 percent from 1984 to 1995 (fig. IV-2). The flow of people into Absarokee would be limited by the availability of housing and the capacity of the sewer and water system. (See Community Services.) The Columbus population would grow 12.7 percent from 1984 to 1995. The Fishtail-Nye area would grow about 9.1 percent during the same period and the Columbus Division would grow about 7.5 percent. Stillwater County as a whole would grow 8.6 percent due to the project.

At the close of operations, whether at the scheduled 30 years or earlier, a significant percentage of the mine-induced population could leave the county. Exactly how many people would leave after a permanent closure depends on individual factors, such as the possibility of early retirement, other income, and the chance of obtaining a job elsewhere. The largest outflow could be from Absarokee, since the community would contain a large percentage of the

TABLE IV-7

Population Projections With and Without the Stillwater Project

Area	1995 Population Without Project	1995 Population With Project	Percent Increase
Stillwater County	6,515	7,025	7.8
Absarokee	890	1,110	24.7
Columbus	1,655	1,845	10.3
Fishtail-Nye	700	760	8.6
Columbus Division	510	550	7.8

Source: Stillwater Mining Company, 1984c, p. 11a.

TABLE IV-8

Expected Distribution of Persons Moving into Stillwater County

Location	1984	1990	1995	2000	Population Increase from 1984 to 1995
Absarokee	790	190	220	220	27.8%
Columbus	1,500	200	190	190	12.7
Fishtail-Nye	660	80	60	60	9.1
Columbus Division	530	40	40	40	7.5
Stillwater County	5,900	510	510	510	8.6

Source: Stillwater Mining Company, 1984c, p. 11a.

mine-induced population, could not provide many other jobs, and is beyond commuting distance to other areas with job opportunities. Columbus would probably shrink less.

Most population decline in the area would occur gradually, not immediately. The rate at which people leave would depend on a variety of factors, such as the benefits received, the length of unemployment, the season of closure, and ties to community family and friends.

Values

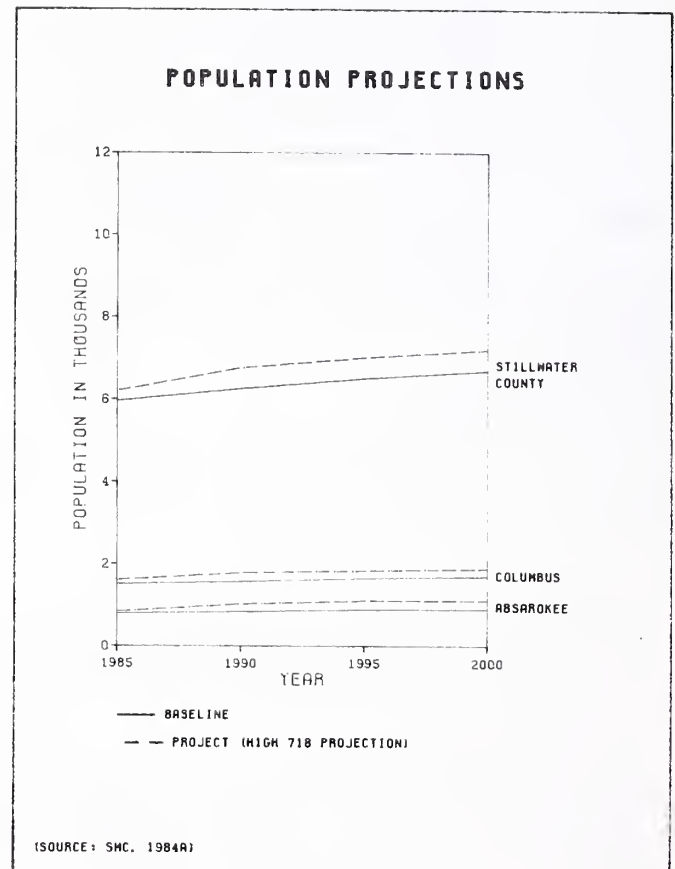
How the values of newcomers would differ from current residents is not known. How much commitment they would have to their new community is not known.

Housing

The current housing stock in Columbus, Absarokee, and Stillwater County is inadequate to accommodate the in-migrating labor force of the Stillwater Project (Housing Development Associates, 1984, p. 27). Furthermore, the early demand for temporary and permanent housing during the first 24 months of the project would be greater than the amount of housing needed throughout the life

FIGURE IV-2

The town most affected by the project would be Absarokee, whose population in 1995 would be nearly 25 percent greater than in 1985 as a result of the project. The population of Columbus would be only 10 percent larger and Stillwater County as a whole only 8 percent larger.



of the project. The severity of the problem would be influenced by the location of in-migrants and the scheduling of hiring by the company.

Local housing contractors in Stillwater County and the Billings area indicated that 200 dwelling units could be constructed annually if demand for housing exists. Local contractors said that three to seven months is required to build a house. Banks in Stillwater County and Billings indicated a willingness to finance homes for members of the Stillwater Project permanent work force if employees can meet loan requirements (Housing Development Associates, 1984, p. 21).

The impact of the project in housing and land values is difficult to predict. Such price impacts would depend on housing supply and demand, which would depend to a large degree on the number of in-migrating employees and the location preferences of such in-migrants. If the company hires 40 percent of its work force locally, and if in-migrants settle as projected in Employment and Income, housing demand could outstrip the supply in the initial years of the project. Housing and land prices could increase initially and then decline under such a scenario. However, if a greater number of local residents are hired by the company, housing demand would not be as great and housing and land values would be more stable.

Project Concerns

Chapter III details the concerns expressed by county residents over the project proposed by Anaconda in 1981. The following discussion addresses the likelihood of the occurrence of those concerns due to the Stillwater Project.

The Stillwater Project would provide an additional 223 jobs. Approximately 89 of these jobs are expected to be filled by persons already living in the county (Stillwater Mining Company, 1984c, p. 8).

It is not known if the cost of living in the county or local areas would rise more during mine construction and operation than it would in other areas of the region. Housing prices could rise initially until the housing supply caught up with new demand. However, if too many housing units were constructed, housing values could fall. Seventy-nine percent of the residents surveyed stated that they thought the cost of housing would be worse if the mine were developed (Entercom, 1981). It is not known if or how much housing prices would rise or fall. Land prices might rise with the development of the project, which could cause difficulty to ranchers attempting to expand their operations.

Ranchers moving cattle along the roads between the minesite and Nye (about 7 miles) would be inconvenienced by the additional traffic generated by the increased population, and by mine and mill workers commuting to work. Increases in traffic also would result in more vehicle accidents and deaths. (See Transportation.) The traffic could also be viewed by some residents as a reduction in privacy.

Wage rates for ranch workers should not rise as a result of the project. For comparison, between 1970 and 1979 Rosebud County experienced a large increase in mine employment due to coal development. Despite this large increase in mine employment, the average annual income of local farm workers increased at a slower rate than did the income of farm workers statewide (U.S. Department of Commerce 1980a, 1980b, 1981a, 1981b). The level of development in Rosebud County was much greater than the development that would result from the Stillwater Project.

Any potential impacts of the Stillwater Project on the guide and outfitting business are likely to be small. Stewart et al. (Feb., 1982, p. 32) project rapid future increases in already high levels of hunting of the Stillwater elk herd. Tighter hunting controls are likely to be instituted even without the project. The secondary economic effects of outfitting (effects on other county businesses) are also small; despite the loss of jobs caused by tighter controls, no noticeable difference in the overall employment, income and population projections would result.

The project would not cause rapid social change in the county. Nor would the increased population much alter the existing political structure of the county. Newcomers may have different expectations of local government, such as types of services they believe should be provided, but their proportion of the county population would be small, and they would therefore not constitute a threat to existing county government practices. In Absarokee, in contrast to the county as a whole, newcomers would make up 20 percent of the population

by 1995; thus they could influence decisions at the local level. The population increase may give current Absarokee residents the feeling that they have less control over matters affecting their community.

Some persons may move to Stillwater County expecting to work at the Stillwater Project. If such persons are not employed by the company, several outcomes are possible. They may leave the area seeking work elsewhere, or they may find another job in Stillwater County. Some current county residents expressed concern that such persons would remain in the county and qualify for public assistance. The likelihood of increased public assistance caseloads is difficult to predict. Unemployed job seekers may have adequate savings to support themselves or may prefer to seek employment elsewhere rather than receive public assistance.

Mine Closure

Following shutdown of the project, a new social setting would arise. The setting would be unlike the setting either before or during mining. The postmining social life would depend on such factors as how well the mine-related population integrated into the community, the postmining mix of "new" and "old" residents, and demographic characteristics of the postmining community.

Out-migration of unemployed workers and their families depends on several factors including the length of time they have been unemployed, the duration and their eligibility for unemployment benefits, their financial status, and emotional ties to the community, family and friends (MacFadyen, 1983, p. 19). It is unknown how many unemployed workers and their dependents would leave the area.

Mitigating Measures

- o The company could develop homesites on the 340 acres it owns adjacent to Absarokee. Such development would require construction of a separate sewer and water system or upgrading the capacity of the existing Absarokee sewer and water system.
- o To alleviate the most critical period of housing demand, the company could delay hiring the permanent work force until a part of the temporary work force has left the area. In this way, some housing units could be used by both work forces.
- o The company could acquire some existing housing and make it available for Stillwater Project workers. The company could provide financial assistance to employees desiring to build or purchase homes.
- o The company could provide bachelors' quarters, temporary mobile home/recreational vehicle parks, or apartment housing to alleviate the initial pressure on housing due to in-migration of temporary workers.

- o Bussing mine employees to and from work could decrease traffic, resulting in fewer vehicle accidents and less inconvenience to ranchers moving cattle.

Impacts Unique to the Proposal and Alternatives 1, 2, 3, 4, and 6

No impacts would be unique to the proposal or alternatives, 1, 2, 3, 4, and 6.

Impacts Unique to Alternative 5

Alternative 5 would substantially increase truck traffic on the 7-mile segment of road between the minesite and Hertzler Valley (FAS 419 and 420). Twenty- or 25-ton trucks would make 50 to 60 round trips per day between the mill and mine. Increased truck traffic would inconvenience motorists and ranchers moving cattle and could increase the likelihood of accidents. Truck traffic may also increase the traffic noise level. (See Noise.)

COMMUNITY SERVICES

Summary of Impacts of the Proposal and Alternative 4: Impacts to community services would be the same under all alternatives because the number of people moving into the Stillwater Valley under each alternative would be roughly equivalent. Projected impacts to community services are based on the assumptions that in-migrants will locate as described in Employment and Income. Stillwater County would need additional staff, as would the Sheriff's Department and Department of Social Services. Expansion of the Absarokee sewer system, additional solid waste containers, expansion of the Columbus water system and sewer system, and an additional deputy in the Columbus Police Department would also be needed to accommodate increased population. Most area schools would need additional teaching staff and classrooms.

The demand for services presented below represents the amount needed in addition to that given in chapter III, that is, the demand added by the population increase arising from development of the proposed project. All project alternatives would cause essentially the same impacts to community services. Differences are noted in the appropriate sections. The information contained in the following discussion is drawn from the Stillwater Mining Company Hard Rock Mining Impact Plan (1985) unless noted otherwise.

Stillwater County

County services that would be affected by the population increases resulting from the Stillwater Project include administrative services, law enforcement,

IV-56 / Community Services

and social services. Three special districts have been organized to provide county-wide solid waste collection and to fund and operate the Absarokee sewer system, and would also receive impacts from the population increase.

County Administration

Two and one-half additional full-time employees (FTEs) would be needed in the first four years of Stillwater operation. One FTE would be needed to assist the county commissioners. The planning department would require an additional FTE which would decrease to a quarter-time FTE in year five of the Stillwater Project. The county sanitarian would require an additional half-time FTE.

Law Enforcement

The Stillwater County Sheriff's Department would need an additional deputy and an additional vehicle. The additional officer would be needed in the southern portion of the county, probably Columbus or Absarokee, which will receive the majority of the population influx. The operating costs of the jail, county attorney, and justice of the peace would increase in proportion to the in-migrating population. That is, for each new person moving into the county, annual operating costs would rise by an estimated \$1.15 for the county jail, \$7.00 for the county attorney, and \$6.00 for the justice of the peace.

Social Services

Population growth associated with the project is expected to increase the social services workload and create a need for an additional social worker. Annual costs of the county general assistance program are expected to increase from \$3.00 to \$6.00 per county resident. For other assistance programs the cost is expected to remain constant at \$6.60 per in-migrant (Stillwater Mining Company, 1985, p. 20).

Other Services

The per capita cost of other services provided by the county are expected to remain constant. Per capita costs today for the district court are \$14.00; for the library, \$5.00; for mental health, \$2.40; and for alcohol rehabilitation, \$3.00. The total cost of each of these services is expected to increase in direct proportion to the number of in-migrating persons. For example, if 100 persons move into the county, annual county mental health costs would increase by \$240.00.

Solid Waste Collection

Six additional green boxes would be needed to serve the in-migrating population--four at Absarokee, two in the Nye-Fishtail area, and two to serve the Stillwater Project. No additional collection trips per week are anticipated. Per capita disposal costs would remain constant at an estimated \$9.00 per year.

Sewer System

Two rural improvement districts (5 and 7) provide sewer service to Absarokee. Additional treatment capacity (surface aeration and lagoon area) is needed to accommodate projected population growth in Absarokee. Such improvements would require an estimated \$200,000 capital outlay and \$20,000 in annual operating costs (Stillwater Mining Company, 1985, p. 25).

Absarokee Water Users Association

The existing capacity of the Absarokee water system is adequate to serve 2 to 3 times the existing population (BMML, 1982, p. 9-40). However, if more than the projected 220 persons settle in Absarokee, and if system distribution leaks are not reduced below 125,000 gpd, an additional well or storage will be needed (Jim Tyson, Manager, Absarokee Water Users Associations, pers. com., January 25, 1985). The association has continued to repair the distribution system, allocating \$33,000 in 1983 and 1984 for repairs (Ruth De Groat, pers. com., January 10, 1985). Depending on the total population increase and system repairs, existing capacity may be adequate.

Town of Columbus

Government functions and services provided by the town of Columbus that would be affected by the Stillwater Project include law enforcement, street maintenance, recreation facilities, government administration, sewer and water systems.

Law Enforcement

An additional police officer, an additional vehicle, and additional office space would be needed in Columbus to provide 24-hour on-duty law enforcement. Operating costs are assumed to increase for the city attorney at the current per capita rate of \$5.67 and for the police court at the current per capita rate of \$2.33.

Street Maintenance

Grading, resurfacing, reconstruction, and drainage work would be required on some streets in Columbus. Maintenance and operation costs are expected to increase to about \$4,500 annually--about double the amount expected in year 1 of the project (Stillwater Mining Company, 1985, p. 39).

Water and Sewer System

All improvements to the sewer and water systems are necessary to adequately serve the existing residents of Columbus (see Community Services, Chapter III). However, Stillwater Mining Company will loan the town an amount sufficient to fund the estimated cost of repairs (Stillwater Mining Company, 1985, pp. 48-49).

Schools

Approximately 20 percent of the enrollment in the Absarokee elementary school (district 52-C) would be attributable to population growth caused by the Stillwater Project. Population in-migration would add 50 new students to the Absarokee elementary school over 10 years. Such an increase would necessitate hiring a principal and up to three and one-half more teachers, depending on the distribution of children among grades K-8 and special education; expanding cafeteria capacity; adding another school bus; hiring a part-time support personnel; and constructing three classrooms (Stillwater Mining Company, 1985, pp. 54-57). If the existing student/classroom ratio (19:1) is preserved, three additional classrooms would be needed.

Twenty-five new students are expected to enroll in the Absarokee High School (district 52) due to Stillwater Project population growth. No additional teachers or classrooms are anticipated to be needed if the existing capacity is judged according to current state accreditation standards (table IV-9), and if students are distributed throughout all grades. However, if the existing teacher/student (1:11) and classroom/student (1:12.4) proportions are maintained, two additional teachers and one additional classroom would be needed.

Enrollment in the Columbus Elementary School (district 6) is expected to increase by 37 to 40 students at the beginning of the Stillwater Project and in later years level off at an increase of 55 to 60 students. Because students would not be split evenly among the grades, one to two additional teachers and up to three additional classrooms would be needed. A half-time cook would also be needed as well as a half-time principal (Stillwater Mining Company, 1985, p. 73).

TABLE IV-9

Montana School Accreditation Standards

Grade	Number of Students Per Teacher ¹	Number of Students Per Classroom
Kindergarten	22	24
Grade 1	20	26
Grade 2	24	26
Grades 3-4	26	28
Grades 5-8 ²	28	30
High School ²		30

Source: Susan Dandliker, Accreditation Specialist, Office of Public Instruction, pers. com., Dec. 17, 1984; and Board of Education, [no date], pp. 21-22.

¹Student/teacher ratios are recommended standards and not enforceable.

²There are no limits on the number of students per classroom for choral or instrumental classes. Typing and physical education classes are limited to 45 pupils per classroom.

The Columbus High School (district 6) would undergo an enrollment increase of 25 to 30 students due to Stillwater Project in-migration. Increased enrollment in Columbus High School would require 1 additional teacher and 1 classroom (Stillwater Mining Company, 1985, p. 82).

Seven additional students are projected to enroll in the Nye Elementary School (district 31), and ten new students would enroll in the Fishtail Elementary School (district 13) (Stillwater Mining Company, 1985, p. 52). Both schools have adequate capacity to absorb the increased enrollments.

The Effects of Mine Closure

The mine and mill are scheduled to close in 30 years, but the operation could close earlier, or close temporarily at any time. Very little would happen to Stillwater County if the project shut down temporarily for a short period. Few people would leave; housing demand would change little; community services would continue at the same level; and social life would go on much as before. When the closure appears permanent, however, lasting changes would take place.

The most significant changes would arise after the county adjusted to the population brought in by the mine. The time needed for the initial adjustment--for the increases in facilities and services--would amount to two to three years. A mine closure could then cause a minor increase in vacant housing units in Columbus. In Absarokee, the increased vacancy rate would be more apparent. How many of the mine-related housing units in Absarokee would be left vacant depends on the type and location of the units and the percentage of the population that departs. Temporary housing, especially mobile homes, would probably be moved by the owners.

Impacts on community services would also be most apparent in Absarokee. The degree to which community services in Absarokee would be affected by closure depends on how the services had been expanded to accommodate the increase in population from the project. For instance, expansion of staff could be easily overcome by simply decreasing employee numbers. Overcoming facility expansion and eventual surplus would be more difficult. Any facilities not dismantled and without alternative uses might increase operation and maintenance costs but not service quality. Although Absarokee is not expected to expand facilities greatly to accommodate the mine, even a small excess of capacity could be a financial burden for the community.

Mitigating Measures

Developers of large-scale hard rock mines or associated milling facilities are required by law to prepare a fiscal impact plan describing the impacts that a proposed development will have on units of affected local government (90-6-307, MCA). The plan shall include the estimated number of persons expected to come into the affected area, the increased capital and operating costs to units of local government, and the financial or other assistance that the developer will provide to such governments (90-6-307(1), MCA). Developers are required to pay all increased capital and net operating costs to affected local government units (90-6-307(2), MCA).

IV-60 / Community Services

State law also contains tax-base-sharing provisions designed to distribute tax revenue among counties, municipalities, and school districts according to the number of mineral development employees living within the jurisdiction. Municipalities may receive a portion of the taxable value not to exceed 20 percent; such portion is to be distributed among municipalities according to the percentage of the total number of mineral development employees living in each municipality. The remaining portion of taxable value must be distributed among each affected county according to the percentage of mineral employees living in each county. High school and elementary districts receive a pro-rata share of the taxable valuation of the hard rock mine according to the percentage of the total number of mineral development students living in each district (90-6-404, MCA).

Stillwater Mining Company and Stillwater County have prepared an impact plan that describes expected impacts to and proposed payments for community services provided by the county, Absarokee, Columbus, school districts, and special districts. Therefore, all impacts except those occurring to the Absarokee Water Users Association and the hospital would be mitigated by Stillwater Mining Company. The impact plan has been submitted to the county for a 90-day review. The plan identifies expected impacts and financial mitigations proposed by the company. The final plan adopted by Stillwater Mining Company and Stillwater County may vary from the current proposal; however, the company is responsible for paying all increased net operating and capital costs of units of local government due to the hard rock development (90-6-307(2), MCA). The impact plan identifies a total tax prepayment of \$2.3 million (excluding contingent funds) to cover increased costs of providing community services and facilities due to in-migrating mine and mill employees (Stillwater Mining Company, 1985, p. iv).

Grants and loans from the hard-rock mining impact trust account are available to units of local government when a mining operation has permanently ceased operations or has reduced its full-time equivalent mining work force by 50 percent over the preceding 5-year period (90-6-321(1), MCA). (See Fiscal Conditions.) The Hard-Rock Impact Board may award grants and loans to pay for outstanding capital project expenses, to decrease unusually high property tax revenues, and to promote development of new industry or new employment opportunities in the area (90-6-321(2), MCA).

FISCAL CONDITIONS

Summary of Impacts of the Proposal: The proposal (and all alternatives) would increase the assessed value of property in Stillwater County by \$4,396,382. The assessed value would indirectly rise another \$343,000, owing to construction of residential and commercial property. The proposal (and all alternatives) would also return annually to the state \$419,441 in metalliferous mines license tax revenues and \$116,063 in resource indemnity trust tax revenues at full production, assuming current metal prices.

Summary of Impacts of Alternative 4: Alternative 4 would increase the assessed value of property in Stillwater County by \$4,480,382. The indirect increase in property tax would amount to another \$343,000. Metalliferous mines license tax revenue collections would amount to \$419,441 annually. Alternative 4 would also produce \$116,063 in resource indemnity trust tax revenues.

Impacts All Production Systems Have in Common

The proposal and all alternatives would generate nearly the same amount of direct and indirect tax revenue. This similarity would result from equal levels of employment and similar types and amounts of mine equipment.

Property Tax Base

The Stillwater Project would add about \$3,700,000 to the Stillwater County real property tax base (Stillwater Mining Company, 1984c, p. 20A). An indirect increase in taxable value of approximately \$343,000 would result from residential and commercial property built by in-migrants (Stillwater Mining Company, 1984c, p. 20A). Increases in taxable value would occur gradually over the life of the project, reaching a stable level during the project's sixth year.

Three percent of the gross proceeds of metal mines are subject to property tax (15-6-132(2)(a), MCA). At full production, Stillwater Mining Company would contribute \$696,382 in gross proceeds to the tax base of Stillwater County at current metal prices (table IV-10). Gross proceeds tax revenues would fluctuate with the value of metals.

TABLE IV-10

Annual Production and Gross Value of Minerals

Mineral	Amount (troy ounces)	Value Per Troy Ounce	Total value
Platinum	29,207	\$ 275	\$ 8,031,925
Palladium	102,465	128	13,115,520
Rhodium	891	1,040	926,640
Iridium	347	475	164,825
Osmium	248	950	235,600
Ruthenium	50	160	8,000
Gold	2,426	301	930,226
TOTAL	135,634		\$23,212,736

Source: U.S. Bureau of Mines, 1981; Metals Week, February 11, 1985, p. 5.

IV-62 / Fiscal Conditions

It is difficult to predict whether the increased taxable value added by the Stillwater Project would raise or lower the property tax mill levy of the local government jurisdictions affected by the project. Mill levies would depend on the cost of providing services to in-migrating persons and current residents compared to available revenues.

Metalliferous Mines License Tax

The state of Montana would receive an annual license tax from the proposed mine. The tax paid would amount to \$86,250 plus 1.5 percent of the gross value of mine's production over \$1,000,000 per year, or about \$419,441 per year. Over the life of the mine the total tax revenue would amount to about \$10,486,025, assuming constant prices and a 25-year mine life. The actual amount would depend on the price of the various metals.

Resource Indemnity Trust Tax

The state levies a tax against all mining in Montana of \$25 plus 0.5 percent of the amount of the gross value of the production in excess of \$5,000. The tax is paid into the Resource Indemnity Trust Fund, which is intended to provide security against loss or damage to the state's environment from the extraction of nonrenewable mineral resources. The tax from the proposed mine would amount to about \$116,063 per year; at current prices and assuming a 25-year mine life, a total of \$2,901,592 would be paid into the trust fund.

Impacts Unique to Alternatives 1 and 5

Alternatives 1 and 5 would have no unique fiscal impacts.

Impacts Unique to Alternatives 2, 3, 4, and 6

Alternatives 2, 3, 4, and 6 would further increase the tax base of Stillwater County. Each of the alternatives would include construction of a slurry line, which would increase the property tax base by approximately \$84,000 for alternatives 2 and 3, and \$250,000 for alternatives 4 and 6 (table IV-11).

Mine Closure

A temporary closure of the mine would lower receipts of the gross proceeds property tax, the license tax, and the resource indemnity trust tax. The tax on real personal and commercial property and equipment would remain stable. Total taxes foregone would depend on the length of the shutdown and metal prices.

Permanent closure of the mine would eliminate the gross proceeds, metal license tax, and resource indemnity trust tax proceeds and substantially reduce the real property tax as the company dismantled and/or divested itself of equipment and property. Depending on job availability and out-migration of mine employees, the value of residential and commercial property may change, which would also affect property tax collections.

TABLE IV-11

Taxable Value of Slurry Lines Under
Alternatives 2, 3, 4, and 6

Alternative	Cost to Construct Slurry Line ¹	Taxable Value of Slurry Line	Total Taxable Value
2	\$ 763,090	\$ 83,940	\$3,783,940
3	763,090	83,940	3,783,940
4	2,289,270	251,820	3,051,820
6	2,289,270	251,820	3,951,820
Proposal	- 0 -	- 0 -	3,700,000

¹Value of slurry line ± 25 percent.

LAND USE

Summary of Impacts of the Proposal: The direct land use impacts of the project would be temporary and would not significantly affect land use patterns in the area. About 165 acres would be disturbed by the mine, mill, and tailing pond and as many as 41 acres of other lands could be permanently converted to residential uses. The proposed postmining land uses of wildlife habitat and recreation would be feasible; the reclaimed range condition would be better than it is now; however, the range condition would gradually decline to premining levels. Wildlife habitat reclamation would be generally successful.

Summary of Impacts of Alternative 4: Alternative 4 would temporarily displace agricultural production and other area land uses on 256 acres for the proposed 30-year mine life. Such changes would not significantly alter land uses within Stillwater County. As much as 41 acres of land could be permanently converted to residential uses. Postmining land uses such as wildlife habitat and recreation would be feasible.

Impacts All Production Systems Have in Common

The proposal and all alternatives would have equivalent land use impacts at the minesite. The area around the minesite is dominated by land disturbed by previous mining (fig. III-18). Reclamation would eventually reestablish adequate vegetative cover to allow use of the area for recreation and wildlife habitat. (See Soils, Vegetation, and Wildlife Habitat.)

If each of the 165 mine and secondary workers moving into the area build a new home (average 0.25 acre of land), instead of purchasing or renting an

existing house, a total of 41 acres of agricultural land could be permanently removed from production. The total amount of agricultural land converted to new housing development could be less, depending on the location and housing preferences of in-migrants. Such land use conversion would have an insignificant impact on agricultural production in Stillwater County.

Impacts Unique to the Proposal

The proposal would disturb 165 acres of land within the permit area, of which 59 acres are classified as rangeland (table IV-12). Assuming the permit area would be removed from agricultural use during the 30-year life of mine, between 991 and 1,044 animal unit months (AUMs) of grazing would be lost. The lower number represents the recommended stocking rate under current range conditions. The upper number represents the potential stocking rate under excellent range conditions.

Impacts Unique to Alternative 1

Total foregone livestock production would be the least under alternative 1: Only 38 acres of rangeland would be disturbed (table IV-12). During mining a potential 660 AUMs would be lost.

TABLE IV-12

Acres of Rangeland Disturbed Under Each Alternative and Livestock Production Foregone

Alternative	Acres of Rangeland Disturbed	Per Acre Recommended Stocking Rate ^{1,2}	AUMs Foregone Over Life of Project ⁴	Per Acre Potential Stocking Rate ^{1,3}	AUMs Foregone Over Life of Project
Proposal	59	.56	991	.59	1,044
1	38	.57	660	.57	660
2	151	.47	2,130	.57	2,580
3	103	.46	1,421	.55	1,700
4	195	.36	2,106	.5	2,925
5	207	.35	2,174	.5	3,105
6	159	.36	1,717	.5	2,385

¹ Stocking rates are calculated as a weighted average of stocking rates for each type of rangeland occurring within each alternative by U.S. Soil Conservation Service guidelines (USCS, 1981).

² Recommended stocking rate is the number of cattle per month per acre recommended for an area.

³ Potential stocking rate is the number of cattle per acre which could be grazed assuming the best possible land use management techniques.

⁴ AUMs foregone over the life of the project is the number of acres times the stocking rate times 30 years.

Impacts Unique to Alternative 2

Mining under alternative 2 would disturb 151 acres of rangeland. Approximately 2,130 to 2,580 AUMs would be lost during the 30-year mine plan.

Impacts Unique to Alternative 3

Under alternative 3, 103 acres of rangeland would be disturbed. Over the life of the project, 1,421 to 1,700 AUMs would be foregone.

Impacts Unique to Alternative 4

Alternative 4 would disturb 195 acres of rangeland. Over the life of the project, 2,106 to 2,925 AUMs would be lost.

Impacts Unique to Alternative 5

Alternative 5 would disturb the most rangeland--207 acres. Approximately 2,174 to 3,105 AUMs would be lost over 30 years.

Impacts Unique to Alternative 6

Total rangeland disturbance under alternative 6 would be 159 acres. A potential of 1,717 to 2,385 AUMs would be lost during the life of the project.

TRANSPORTATION

Summary of Impacts of the Proposal and Alternative 4: Travel related to the proposed mine would increase traffic volumes on FAS 419, FAS 420, and FAP 78 because of increases in work, household, and truck trips. FAS 419 and 420 would be most affected by work traffic, FAP 78 by household trips. Increased traffic would result in increased vehicle accidents and road maintenance costs. Ranchers, recreation travelers, and wildlife could be adversely affected by the increased traffic. (See Recreation and Wildlife.)

Impacts All Production Systems Have in Common

FAS 419

When the mine and mill are at full production, traffic could increase 159 to 178 ADT (average daily traffic) on FAS 419 from Absarokee to Nye if workers and their families locate as projected in Employment and Income. Such traffic

IV-66 / Transportation

would increase 1980 ADT by 50 percent and 1983 ADT by 61 percent. Traffic increases would be most significant between Nye and Fishtail. Mine-related traffic is projected to be 20 percent of total traffic on FAS 419 by 2000 (Stillwater Mining Company, 1984b, p. 17a).

Based on 1977-80 accident rates (table IV-13), over the 25-year life of the mine there would be an additional 368 accidents on FAS 419. Based on 1980 and 1981 statewide rates, (Jack Williams, Chief, Evaluation and Research Bureau, Highway Traffic Safety, Montana Department of Justice, written com., May 18, 1982), 214 people would be injured and 7 would be killed in the additional accidents.

Assuming that road maintenance costs are directly related to traffic volumes, costs would nearly double in the initial years of the project due to the proposed mine. The increased traffic on FAS 419 could hinder the movement of livestock on or across the road and cause added inconvenience for recreational travelers.

Mine-related traffic would necessitate additional repairs to FAS 419 above the amount necessary without the Stillwater Project. Approximately \$1.6 million would be needed in addition to the estimated repair cost of \$5.5 million without the project (Tomas J. Wing, Resource Engineers and Associates, written com., December 10, 1984).

FAS 420

Some minor traffic increases could occur on FAS 420 due to the Stillwater Project. The draft impact plan prepared by Stillwater Mining Company and Stillwater County projects an increase of 40 ADT on FAS 420 due to mine-related travel (Stillwater Mining Company, 1984b, p. 17a). Such an amount would represent a 16.9 percent increase above 1980 traffic counts on FAS 420 and a 21.9 percent increase above the 1983 level.

Over the 25-year life of mine there would be 13 additional accidents on FAS 420 and an additional 6 injuries if projected traffic increases occur.

FAP 78

Average traffic volumes on FAP 78 between Columbus and Absarokee would rise by 448 vehicles, or 35 percent above the 1983 level, assuming that mine workers locate as described in Employment and Income. Based on the 1977-80 accident rates and the 1980-81 statewide injury and fatality rates, over the 25-year life of the mine there would be 258 additional accidents injuring 124 and killing 4 people (table IV-13).

Maintenance costs would increase by about a third in the initial years of the project due to the proposed mine if such costs increase proportionally to traffic volume increases. However, total maintenance costs due to the mine-induced population would decrease as area population increases.

Current and Projected Traffic

Road Segment	Current Conditions (1980)				Future Conditions (Total for 25 years of Operation)			
	ADT ¹	Accident ² Rate	Accidents 1977-80	Injuries ³ Rate	Fatality ⁴ Rate	Net		Fatalities
						Additional ADT	Net Additional Vehicle Miles ⁵ (millions)	
FAS 419 ⁶ (Absarokee to Nye Jct.)	437	8.49	86	.48	.015	283	52.6	214 7
FAS 419 ⁶ (Nye Jct. to Minesite)	260	1.80	4	.48	.015	153 ⁷	7.5	7 0
FAS 420 (Absarokee to Fishtail)	262	5.31	8	.48	.015	40	2.5	13 6 0
FAP 78 ⁶ (Columbus to Absarokee)	1,014	3.35	99	.48	.015	448	76.9	258 124 4
TOTAL			197				732	351 11

¹ ADT=Average Daily Traffic [Sources: HKM Associates, 1981, p. 17; 1980, p. 93; and Department of State Lands, 1985].

² Accident rate=number of accidents per million vehicle miles [Sources: HKM Associates, 1981, p. 18, figure 3; CDM 1981, p. 2.9-12].

³ Injuries/accidents, statewide rate, 1980-81. Source: Williams, written com., May 18, 1982.

⁴ Fatalities/accidents, statewide rate, 1980-81. Source: Williams, written com., May 18, 1982.

⁵ Total net addition of millions of vehicle miles accumulated over 25 years=(average net additional traffic) x (segment length) x (25 years) x (365 days).

⁶ Segment lengths: FAS 419 (Absarokee-Nye) 20.4 miles, FAS 419 (Nye-mine) 5.4 miles, FAP 78 (Columbus-Absarokee) 18.8 miles.

⁷ Alternative 5 would increase traffic along 419 from the mine to the mill by 100 ore-truck trips per day for a total maximum of 316 net additional ADT. Such an increase could cause 28 more accidents with 13 more injuries than the proposal or other alternatives.

IV-68 / Transportation

Bridges

Only three of the ten bridges on FAS 419 are rated as good bridges. Traffic related to the Stillwater Project would necessitate \$95,900 of repairs to bridges above the amount necessary without the project (Thomas J. Wing, Resource Engineers and Associates, written com., December 10, 1985).

U.S. Forest Service Road 846

FR 846 is used by the public to reach the wilderness trailhead on the West Fork of the Stillwater River, as well as other national forest system lands. The road also provides access to the mine exploration road that leads to the 6,550-level adit.

The access road to the 6,550-level adit is discussed in the Forest Service's Environmental Assessment of the 6,550-level adit (on file with Custer National Forest). Use of the road is not covered in Stillwater Mining Company's current application, but rather in the 1981 exploration operating plan. Continued use of the road during full mine operation would have no adverse affect, provided the road is maintained.

In its present location, FR 846 routes the public through the minesite. In the proposal and all alternatives, the road would probably be relocated. The routing of the relocation would depend on the alternative selected.

Mitigating Measures

FAS 419, FAS 420, and FAP 78. Reconstruction of the roads between Columbus, Absarokee, and the minesite could reduce the accident rate. A more effective way to reduce the number of accidents might be intensive patrolling of the road, particularly the first 10 miles south of Absarokee.

Stillwater Mining Company has agreed in the hard-rock mining impact plan to fund 20 percent (up to \$1,460,000) of the cost of reconstructing FAS 419 (including bridges) if additional federal, state, or other funding becomes available prior to 1990. Between 1991 to 1995, the company would contribute 10 percent (not to exceed \$730,000) of the cost of upgrading FAS 419. After 1995 the company will not contribute any special funding (Stillwater Mining Company, 1985, p. 35).

Another way to reduce accidents and at the same time save energy would be to reduce the number of project-related trips by the establishment of a commuter bus service from Columbus for employees. The commuter bus service could be provided directly by Stillwater Mining Company or the company could subsidize an independent transportation system that the employees would be encouraged to use.

To avoid spring breakup of the haul road between the mine and mill, Stillwater County could prohibit vehicles above certain weight limits on FAS 419 and 420.

Local ranchers could partially mitigate the potential conflict between livestock and traffic on FAS 419 and FAS 420 by not moving livestock along the road during shift changes. Stillwater Mining Company should inform ranchers in advance of any change in shift hours. The conflict could be further mitigated by instructing mine employees to give the right-of-way to livestock on the road.

Forest Road 846. The Forest Service would require that Stillwater Mining Company obtain a permit to relocate FR 846. The design for the road would be provided by the company and be subject to approval by the Forest Service. The permit would call for (1) signing adequate to alert public users of the proper route to follow and (2) the construction of a gate at the beginning of the road to the explosive storage site.

The Forest Service would also require a road maintenance agreement with Stillwater Mining Company for FR 846 and the access roads to the upper adits. The agreement would require that Stillwater Mining Company bear a share of road maintenance proportionate to the company use of the road, which is projected to reach 20 percent of the year 2000 traffic level. This agreement would cover the road from FAS 419 to all the adits.

A new road would be built to reach six portals of the mine. The new road would intersect forest road 846 in two places.

Impacts Unique to the Proposal

Approximately 3,000 feet of FAS 419 would be reconstructed because it now passes through the tailing impoundment site (fig. II-2). The road would be reconstructed to meet applicable federal and state criteria (Stillwater Mining Company, 1984c, p. 3.1-17).

A short segment of FAS 419 would be used to transport waste rock and ore to the tailing impoundment or mill (Stillwater Mining Company, 1984c, p. 3.1-17). Haul trucks with 25-ton capacities would be used to haul the waste rock and ore.

Mitigating Measures

Stillwater Mining Company would be required by the Forest Service to improve and maintain the section of FAS 419 used by haul trucks to standards used by the Forest Service and Stillwater County.

Impacts Unique to the Alternatives 1, 2, 3, 4, and 6

There are no transportation impacts unique to these alternatives.

IV-70 / Transportation

Impacts Unique to Alternative 5

Traffic increases due to workers commuting to the minesite and mill would not vary greatly between the other alternatives and alternative 5. However, truck traffic would increase substantially under alternative 5 compared to other alternatives--from two trucks to 100 trucks per day (HKM, 1981, p. 62). The extra trucks would run along 7 miles of 419 and 420 between the mine and Hertzler tailing site. Truck traffic along FAP 78 would be minor (HKM, 1981, p. 62). Under alternative 5, work-related traffic would increase approximately 24 trips per day on FAS 420 between Nye and the mill.

Increased truck traffic would cause inconvenience to motorists, recreational travelers, and ranchers moving livestock. There would also be an increased likelihood of accidents along the sections of FAS 419 and 420 used by the trucks. Noise levels would be greater under alternative 5 than other alternatives due to the truck traffic. (See Noise.)

Mitigating Measures

The company could require truck drivers to give the right-of-way to ranchers moving livestock along the road.

RECREATION

Summary of Impacts of the Proposal and Alternative 4: The project would bring increased use to both the national forest and the private lands along the Stillwater River. This could increase person-to-person contacts; put additional public pressure on the Forest Service to gain new public access routes to the Custer National Forest; increase harvest of fuel wood; and cause weekend crowding at campgrounds. Visual changes and noise from the mill would affect the recreational quality along FAS 419. In addition, traffic from shift changes would cause increased traffic hazards. This would be particularly true on Friday and Sunday afternoons, when recreation travel is heaviest.

Impacts All Production Systems Have in Common

National Forest and Wilderness Recreation Resources

The local area, including Yellowstone County, supplies about 70 percent of the visitors to the part of Custer National Forest near the Stillwater Project. The addition to this area of 120 in-migrating employee families or about 408 people would not measurably affect regional recreational demands; however, since the addition would occur mainly within 30 miles of the affected National Forest lands, some increased pressure on area campgrounds and dispersed areas

would result. This increase could be accommodated within the estimated biological carrying capacity of the area.

The carrying capacities of the national forest lands, however, are finite. They are directly related to the intensity of management. The capacities listed in chapter III (table III-18) are for high intensity management. The Forest Service has found that if the level of management is reduced, the capacity for use without unacceptable biological degradation will be reduced. For example, day-use capacity of the lower Stillwater drainage inside the Wilderness is estimated to be 125 people per day with intensive management. This would be reduced to 75 people per day if wilderness rangers did not patrol the area, enforce local rules, and promote low-impact camping practices. With increased use, National Forest administrative costs would probably rise.

With the exception of holiday weekends, campsites are always available during the summer season. Actual use counts made in July and August in the Rosebud and Stillwater areas indicate only 40 to 60 percent of the existing capacity is being used. Capacity estimates in people-at-one-time (PAOT) made of the roads, roadside areas, and day-use portions of the Wilderness also reveal unused capacity is available. Nevertheless, holiday weekend use reaches capacity now. With the increased use that would be induced by the Stillwater Project, person-to-person contact would increase, both in the campgrounds and in the day-use part of the Wilderness Area around Sioux Charlie Lake on the Stillwater River. Some people would have to seek campsites elsewhere.

Increased use would also put added pressure on the Forest Service to acquire new public access routes to national forest lands, and put pressure on private landowners next to the national forest boundary to allow passage across their land.

Additional demands for fuel wood would also result from the increased number of people. At present demand levels, wood supplies are adequate to meet demand.

Recreation Resources Outside Custer National Forest

On lands that are not part of the national forest, the additional highway traffic would reduce the enjoyment of recreationists using the three sites between the minesite and Absarokee; however, use of the Stillwater River for canoeing, rafting, fishing, and kayaking probably would not decrease as a result of the project.

Deterioration of fishing access sites and campgrounds may occur in other ways. Recreationists would have more difficulty finding an uncrowded access site. Restrictions may have to be placed on the length of camping allowed at the sites to deter temporary mine workers from living there. The Montana Department of Fish, Wildlife and Parks would have to rely on the County Sheriff's Department to control additional use (Ray Burnsten, pers. com., March 2, 1982).

IV-72 / Recreation

The use of commercial dude ranches and outfitters would not be reduced by the project because the area used by outfitters would not be affected. More traffic would pass the dude ranches.

Mitigating Measures

No mitigating action is considered necessary to protect national forest recreation or Wilderness; however, the Forest Service does have the option of increasing on-the-ground administration on national forest lands with the possibility of requiring permits for Wilderness Area use to control an increased number of people.

There are at least two ways of mitigating the traffic caused by mine and mill shift changes. First, shift changes could be disallowed from 2 p.m. to 7 p.m. on Fridays and Sundays, Memorial Day through Labor Day. On three-day weekends, the shift changes could be disallowed from 2 p.m. to 7 p.m. Thursday, instead of Friday (or on Monday instead of Sunday). Second, employees could be bussed to the mine from Absarokee, thereby eliminating some of the traffic created by Stillwater Mining Company employees. No restriction in shift changes would then be necessary. Stillwater Mining Company would be encouraged to take one of these or other appropriate mitigating actions. If increased traffic from mine shift changes were demonstrated to be a safety hazard, the Forest Service would require the company to alleviate the problem.

Impacts Unique to the Proposal and Alternatives 1, 2, 3, 4, and 6

The impacts of the proposal and alternatives 1, 2, 3, 4, and 6 would be the same.

Impacts Unique to Alternative 5 (Mill at Hertzler)

This alternative would create additional adverse effects at the fishing access points, particularly the moraine fishing access site, owing to possible visual quality deterioration.

Projected ore hauling on the County road between Nye and the mine would demand about 50 trucks every 24 hours, or two loaded trucks each hour on the road segment for about ten minutes. Even so, this would not create a significant hazard to recreation travelers on the County road. Visitors would probably pass only one truck going the other way between the mine and Nye; occasionally, they would follow or be followed by a truck moving in the same direction. If the hauling schedule is compressed into a shorter period--to make up for delays, for example--a hazard may occur, especially if additional trucks were put on the road during the periods when recreation visitor traffic peaks.

CULTURAL RESOURCES

Summary of Impacts of the Proposal: No cultural resource sites would be adversely affected directly by the project. Fourteen cultural sites, potentially eligible for the National Register of Historic Places, could be indirectly damaged by increased vandalism or relic collecting.

Summary of Impacts of Alternative 4: With proper mitigating measures, no cultural resource sites would be directly damaged by alternative 4. Fourteen cultural sites, potentially eligible for the National Register of Historic Places, could be indirectly damaged by increased vandalism or relic collecting.

Impacts All Production Systems Have in Common

One cultural resource site is located within the proposed permit boundary next to the existing adits and could possibly be affected by mine-related disturbances or unauthorized relic collecting. Thirteen other cultural resource sites lying within the area of potential impact, but outside the mine permit area, could be adversely affected by unauthorized relic collecting or vandalism.

All of the above sites are potentially eligible for listing on the National Register of Historic Places because of their potential to yield information on the prehistory and history of the area. Further evaluation of most of the prehistoric sites would be necessary prior to a formal determination of eligibility. Of the five sites lying on national forest system lands within the study area, three have been determined eligible for the National Register by the Forest Service and State Historic Preservation Office acting under the recent Advisory Council on Historic Preservation rules suspension.

Prior to approval of the mine permit by the Department of State Lands and approval of a plan of operations by the Forest Service, the agencies are required to inventory and evaluate significant cultural resources within the area of potential impact, and to take measures to minimize or eliminate possible adverse effects (82.4.335, MCA; ARM 26.4.106 (101); and the National Historic Preservation Act, Section 106). Management of significant resources can include avoidance, project redesign, security measures such as posting "no trespassing" signs, or mitigation through data recovery. The Forest Service is responsible for managing cultural sites on lands under its jurisdiction and SMC is willing to take protective measures on its property.

The fourteen cultural resource sites within the study area that are potentially eligible for the National Register of Historic Places are described in tables III-23 and III-24. Of the potentially eligible sites the Hejelvik cabin (24ST67) in the proposed permit area would be the most likely to be adversely affected. The buffalo jump (24ST401) and several associated archaeological sites lie close to or are bisected by FAS 419 and could be adversely

affected by unauthorized relic collecting. A stone ring site, the Guthrie site (24ST54), is bisected by the road and would receive similar impact. Three homesteads (24ST55, 24ST53, 24ST59) would probably not be affected because they are still occupied. Seven other sites (stone features and structural remains of mining or homestead activities) are outside the permit area, but could be affected due both to the increased number of people in the area and to the lack of fences on property lines.

Eleven cultural sites were discovered that are not eligible for the National Register and would not be affected by mining and related activities. These sites have been recorded and the information from them preserved.

Stillwater Mining Company would retain a qualified cultural resources consultant to formally evaluate the Hejelvik Cabin (24ST67) site for National Register eligibility and, if warranted, develop a data recovery plan to mitigate the adverse effects of the proposed demolition of the site. Stillwater Mining Company would coordinate this evaluation/mitigation with the Montana State Historical Preservation Office and Montana Department of State Lands. The proposed new access road to the Mountain View Ridge hoist facility would receive a Class III preconstruction cultural resources inventory by a cultural resource consultant holding a valid Special Use Antiquities permit on the Custer National Forest. Any cultural properties discovered would be evaluated for National Register eligibility. Adverse effects to such properties would be mitigated by road realignment or data recovery in consultation with the Forest Service and the State Historic Preservation Office. Stillwater Mining Company has further agreed to post its property with "no trespassing" signs to discourage relic collecting.

How increased commuter traffic would affect vandalism or relic collecting at sites in the Stillwater Valley is difficult to determine. Most of the archaeological sites along this corridor are hard to see (e.g., scattered stone artifacts) and lie on private lands outside the jurisdiction of the Forest Service or SMC. It is likely that mine workers driving FAS 419 would have no greater adverse effect on cultural sites in the valley than the thousands of recreationists who travel the same road each summer.

If Stillwater Mining Company exposes previously unidentified sites on National Forest land during excavation and construction, the company is required to (1) cease activities that could further damage the site and (2) notify the U.S. Forest Service. If the company exposes previously unidentified sites off National Forest land, it will halt operations that could damage the site and contact the Department of State Lands and the State Historic Preservation Office.

Mitigating Measures

The Forest Service has prepared an evaluation and mitigation plan for the potentially eligible sites lying within its jurisdiction. The Forest Service will restrict access on the jeep trail leading to the area where these sites are located.

Impacts Unique to the Proposal and Alternatives 1, 2, 3, 4, and 6

The proposal and alternatives, 1, 2, 3, 4, and 6 would have no impacts that are unique.

Impacts Unique to Alternative 5

Upgrading the existing county road for use by ore trucks could adversely affect the buffalo jump (24ST401) and several associated archaeological sites. Also affected directly could be the Guthrie site (24ST54).

Mitigating Measures

The suggested relocation of the haul road to avoid the peregrine falcon cliff complex (see Threatened and Endangered Species) would pass near the cave site (24ST52). However, the relocation could be routed to prevent any impact on this site. In addition, the company could either excavate and record the site or monitor it for effects from blasting or other sources of damage.

To mitigate the impacts of road upgrading, the company could completely record, by mapping, excavation, or test excavations, the Guthrie ring site and record the outlying areas of the buffalo jump that overlap the road right-of-way. In addition, the company could have an archaeologist at the project site during construction to assure minimal impact.

AESTHETICS

Summary of Impacts of the Proposal: The mine and mill operation would significantly affect the visual resources at the minesite. The visual quality objectives based on mapping done by CDM (1980) would not be met until some time after the completion of reclamation. The mine would be highly visible to travelers of FAS 419.

Noise levels near the milling complex would increase considerably. However, since the levels decrease rapidly with distance, travelers on FAS 419 would be exposed to only a small increase in noise levels.

Summary of Impacts of the Preferred Alternative: The mine in alternative 4 would have the same impact as in the proposal. The tailing impoundment would change the visual pattern of agricultural land until reclamation was completed. However, the impoundment would not be visible from FAS 419.

IV-76 / Aesthetics

Noise levels near the milling complex would increase considerably. However, since the levels decrease rapidly with distance, travelers on FAS 420 would be exposed to only a small increase in noise levels.

Impacts All Production Systems Have in Common

Landscape

Waste rock would be used in the construction of staging areas at all mine portals. This waste rock would be white to gray in color and would weather slowly. Although the staging areas would conform to the natural slope of the area, the light-colored waste rock would be highly visible even after reclamation.

Roads constructed to reach the adits would also cause visual intrusion. These routes, bordered by side-casted rocks and earth, would be highly visible on the hillside. Visitors using Forest Service Road (FR) 846 would travel through a disturbed area larger than what exists today. These roads would be located in the VQO (visual quality objective) Retention/High area. The ore haul road would be highly visible in an undisturbed area. The relocation of FR 846 would have a lesser impact since it would be in the background of major surface disturbance caused by the mine.

The topsoil stockpile would also be highly visible and would contrast with the surrounding area. The stockpile would be removed during reclamation.

After cessation of mining the VQO of the area would probably be met. All structures would be removed and the area reclaimed.

Noise

The operation would have five major noise sources (table IV-14). The composite noise level assumes all noise sources are heard simultaneously. Next to the mill, maximum noise levels are estimated to be about 90 dB(A) (decibels).

However, since noise levels decrease rapidly with distance (Loucks, 1973; Eldred, 1971), the noise levels at FAS 419 would be about 46 dB(A). Assuming a background sound level of 50 dB(A) (see chapter III), the total sound level would be about 51.4 dB(A). This small increase in the sound level would not be noticeable to travelers on FAS 419, nor to recreationists in the Absaroka Beartooth Wilderness.

Mitigating Measures

Visual

To reduce the color contrast under all alternatives between structures and surroundings, all structures could be painted with flat earth-tone colors characteristic of the surrounding landscape.

TABLE IV-14

Major Sources and Estimated Noise Levels

Source	Estimated Maximum Noise Level 3 Feet from Source (dB(A))	Distance to FAS 419 (feet)	Estimated Maximum Noise Level at FAS 419 (dB(A))
Ventilation Fan, 5,000 Adit Portal	89	450	46
Coarse Ore Storage Area	45	1,000	0
Front End Loader	83	1,000	33
Crushing & Grinding Area	60	1,000	10
Air Compressor Area	70	1,000	20
COMPOSITE	90		46

Source: Stillwater Mining Company, 1984a; Loucks, 1973.

Visibility of the operation could be reduced by planting a mixed conifer shelter belt in two places: (1) on the west side of FAS 419 from 200 yards north of the 5,000-foot adit entrance road to the south end of the tailing dam or waste dump and (2) on the north side of the 5,000-foot adit entrance road from FAS 419 to the adit entrance. Natural-color poles and insulators could be used to reduce the visual effects of the 13-kilovolt line between the mill substation and the Mountain View shaft site.

A visitor's turnout on FAS 846 could be constructed above the project complex with signs to explain the mining operation.

Noise

If the Department of State Lands determined that nearby residents were adversely affected by increased noise levels, the Department would require Stillwater Mining Company to implement measures necessary to reduce nuisance noise levels.

Impacts Unique to the Proposal

The tailing dam would have the greatest visual impact (fig. IV-3). This structure would be visible in the background, middle ground, and foreground from FAS 419 as the visitor approaches from the north. However, because of the rolling hill topography, the dam would be visible from no more than a mile away on FAS 419. Travelers approaching from the south would not see the dam until they were next to it. The view is blocked by a rocky cliff. The 160-foot-high dam would screen the road and adit disturbances from the view of most travelers on FAS 419. The tailing pond would be visible to visitors using FR 846.

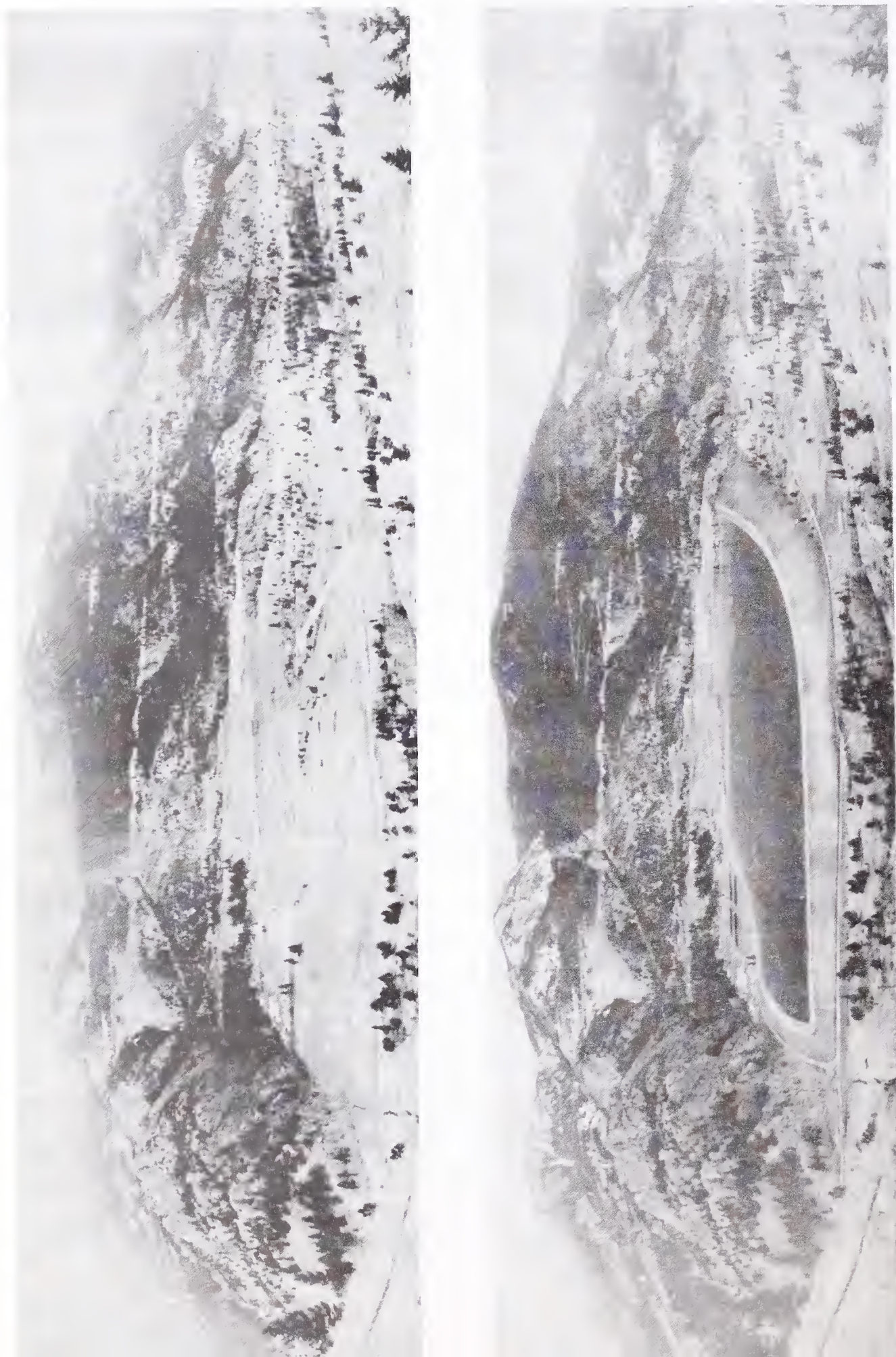


FIGURE IV-3

Retouched photographs show what the area would look like without the project and what it would look like after reclamation--with the facilities removed and the tailing impoundment reclaimed.

Several structures would be added to the landscape. The 70-foot-high crushing facility would stand above the road-user's line of sight from FR 846 and be visible in the middle- and background from points along FAS 419. During reclamation, these structures would be removed. However, the reclaimed tailing embankment would still appear unnatural and the VQO of retention would not be met.

Impacts Unique to Alternative 1

The impacts of alternative 1 would be the same as those described for the proposal, except the tailing dam would be smaller.

Impacts Unique to Alternative 2

The tailing dam would be 150 feet high. It would be located perpendicular to FAS 419 at the Stratton site. The disturbance and visual effect would be similar to that of the proposal. The slurry pipeline would be visible in the borrow pit of FAS 419 from the mill to the tailing impoundment. The tailing pond would be in the foreground and middle ground when viewed from the Cathedral Mountain subdivision and in the background when viewed from other residential developments.

Impacts Unique to Alternative 3

The impacts of alternative 3 would be the same as those for alternative 2, although the tailing impoundment would be smaller.

Impacts Unique to Alternative 4

The tailing impoundment would change the visual pattern of the agricultural land at the Hertzler site until reclamation was completed. The tailing impoundment would not be visible from FAS 419, although it would be visible from FAS 420.

Impacts Unique to Alternative 5

The structures of the mill complex at the Hertzler site would stand above the road-user's line of sight. The top of the 70-foot-high crushing facility would be visible from FAS 419 as a background view. It would be foreground to travelers on FAS 420. The tailing dam structure would be similar to the one in alternatives 4 and 6.

Residents near the haul route on FAS 419 and FAS 420 might be adversely affected by the truck traffic. The trucks would make five one-way trips per hour: A haul truck would pass a given point on the road every 12 minutes. These trucks may produce a noise level up to 80 decibels (dB(A)) measured at 50 feet from the road (Theissen, 1974). This level may be great enough to interfere with normal outdoor activities; some interruption of indoor activity

may also occur (Environmental Protection Agency [EPA], 1974). Since the trucks would operate at night, some residents living close to the road may be awakened (EPA, 1973). However, the increase in noise levels would not be a health hazard (EPA, 1974).

Impacts Unique to Alternative 6

The impacts would be similar to those described for alternative 4, although the tailing impoundment would be smaller.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES AND SHORT-TERM USES VERSUS LONG-TERM PRODUCTIVITY OF THE LAND AFFECTED BY MINING

Stillwater Mining Company would remove 8.3 million tons of platinum-group-metal ore from the Stillwater Complex over 25 years. Some ore would be left owing to its low grade, limits on underground mining technology, and provisions for miner safety. The metal produced would supply about 5 percent of United States demand for platinum and about 20 percent of demand for palladium. The mine would also provide considerable tax revenues, royalties, and jobs. These benefits would be gained at a cost of short-term vegetative, wildlife, and livestock productivity.

The topography of the tailing pond site would be changed permanently. The impounded tailings left after mining would be contoured to drain naturally and would be revegetated. Still, even to the casual observer, the uniform, massive tailing embankment would appear unnatural.

Some native vegetation would be lost during mining. Revegetation would create new vegetation types, but plant diversity and tree and shrub densities would be lowered for decades. Some woody species and some warm-season grass species may be eliminated from the disturbance area. Over the years, both diversity and density would slowly increase.

Revegetation would initially increase livestock forage production. Over the long term, however, forage would decline to near premining levels.

Reductions in long-term vegetative productivity as a result of soil impacts would be minimal or negligible. In the short term, a reduction in vegetative density, diversity, and vigor would probably occur that could last for several years, caused by the loss of soil organic matter, the reduction or loss of soil microorganism populations, and unavoidable impacts on soils.

As long as the mine operates, wildlife would be displaced from the disturbance area. Big game in adjacent areas could be displaced or could experience adverse physiologic effects from nearby disturbance. A golden eagle nest site would probably not be used during or after mining. After the mine closes, revegetation would allow wildlife to return to the area. However, years would be required to return wildlife forage and cover to levels

provided by premining, native habitats. Moreover, since Stillwater Mining Company does not plan to replace exactly premining wildlife habitats, original habitats would be lost.

Housing construction would permanently remove an unknown portion of deer ranges. Other indirect impacts (increased traffic and recreation) would decline over the long term if mine closure decreases the local population.

Fishing pressure along the Stillwater River and its tributaries would increase as a result of the population growth stemming from the Stillwater Project. In the long term, fishing pressure from mine-related population would decline, although natural population growth would maintain fishing pressure at relatively higher levels.

Up to 41 acres of agricultural land and wildlife habitat could be converted to residential housing and permanently removed from production. In addition, the power line could remove some land from agricultural and wildlife uses.

Traffic increases could cause 719 additional accidents, and 11 deaths under the proposal and alternatives, 1, 2, 3, 4, and 6. Alternative 5 would substantially increase truck traffic, which could result in an additional 28 accidents and no additional deaths.

The increases in numbers of people will cause heavier use of state fishing access points. These will be overcrowded, particularly on weekends, thus reducing the quality of recreation.

The increases in numbers of people would also cause more use of national forest system lands. This would not create a need for immediate expansion or addition of facilities. However as a part of a general increasing trend in population, the overall increase would create the need for expanded facilities at Woodbine Campground, the addition of a new campground along the West Fork of the Stillwater and possibly other areas.

The added traffic caused by mill and mine workers one hour prior to and one hour following shift changes would be a significant impact. The two-lane road between the mine and Absarokee would have a peak load of 75 to 150 cars during that period. This added load on Friday and Sunday afternoons could make driving slow, traffic conditions crowded, and decrease the safety of National Forest users.

IMPACTS OF THE PROPOSAL AND ALTERNATIVES:

-MINE PORTAL ARRANGEMENTS

-POWER ALTERNATIVES

-WEST FORK OF THE STILLWATER ROAD ACCESSES

Three groups of alternatives remain to be analyzed: mine portal arrangements, power-line corridors, and access routes to the West Fork of the Stillwater River. The alternatives described in this chapter can be implemented in any combination, no matter what production system is chosen.

MINE PORTAL ARRANGEMENTS

The agencies and the company have identified three possible portal arrangements.

The proposal: 11 portals

Alternative 1: 2 portals

Alternative 2: 8 portals

Proposed Portal Arrangement

Impacts under the proposed portal arrangement would be greater than under either alternative. The 5,350-, 6,150-, and 6,350-level portals and associated roads (fig. II-2) would require excavation on previously undisturbed slopes. These slopes have been mapped by the company as unstable or potentially unstable. The main concern is rockfalls. The company may need to install cribbing and retaining walls to minimize rockfall on roads and portal sites.

The new roads would also impinge on the large surface failure complex above the minesite. The probability of destabilizing portions of the failure are low (Oriard, 1982). A number of roads cut across this surface failure complex today without any noticeable effects. Even so, precautions should be taken to avoid excessive wetting of any portion of the slide through construction practices that channel or pond water.

Increasing the number of surface openings into and next to the crown pillar could further weaken this zone by opening old fractures and creating new ones. This weakening might increase the chance of crown pillar collapse. (See chapter IV, Geology.) On the other hand, the additional openings could facilitate mine backfill, should a backfill alternative (production system alternatives 1, 3, and 6) be chosen.

V-2 / Mine Portal Arrangements

Soil impacts would be similar to those discussed for other parts of the operation. (See chapter IV, Soils.) A total of about 14 acres of soils, talus, and rock outcrop would be disturbed by the new mine portals and access roads. Since two-lift soil salvage is not proposed, organic matter concentrated in the surface layer of undisturbed soils would be diluted with the sub-soil material and lost during salvage. This loss, in combination with the many coarse fragments in the soils and shallow soil depths in the upper elevations, would result in lower postmining water- and nutrient-holding capacities.

During most of the growing season, droughtiness could delay initial revegetation. Although overall precipitation would be greater at the upper-elevation sites than at the tailing site, most of the effective precipitation still occurs between March and June. The droughtiness is evidenced by the sparse vegetation now covering the 6,550-level existing portal area after two growing seasons. Vegetative cover in this area ranges from less than 15 percent to a maximum of about 40 percent. The soils appear to have little or no organic matter. (It should be noted here that, although the revegetation cover was low during the field visit, erosion problems were not observed. This is probably the result of the coarse nature of the soil promoting a high infiltration rate and rapid permeability.)

New roads constructed to serve the various adits would have to be designed in accordance with Forest Service road specifications. Erosion bars, hay bails, and large drainage ditches would be used to minimize erosion off the new roads. Offsite impacts would be negligible.

The amount of water discharging from the new adits would be small and could easily be handled by small-diameter pipes. This water would be either sent to the tailing pond or the sedimentation/percolation pond. No offsite water impacts are expected.

Perhaps the greatest impact of the proposed mine portal arrangement would be visual, although not all portals would be visible from FAS 419 or FR 846. The proposal would result in the construction of nine more portals (in addition to the two existing today). To service these portals, the company would have to build a small yard at each portal opening and construct 1.4 miles of new road, resulting in a zig-zag pattern of cut-and-fill slopes visible from the valley below. The company's 13-kV power line that would serve the Mountain View shaft site and the 11 portals would create a straight 20-foot-wide corridor that would be cleared of vegetation.

Mitigating Measures

The impact of low water- and nutrient-holding capacities of soils could be mitigated in two ways. First, topsoil could be salvaged and stored separately from subsoils in areas where the physical nature of the soils as well as the topography allows such an operation. Second, an annual cereal grain crop could be seeded and allowed to grow. This crop could then be worked into the soil prior to planting native perennials. The crop, along with its root growth, would add organic matter to the surface soil layer, which would improve water- and nutrient-holding capacity.

The Forest Service would require road design incorporating 14-foot-wide, full-bench construction, using cribbing and fill slopes where needed. Trees on the downhill slope would be protected.

Portal Arrangement Alternative 1

Portal arrangement alternative 1 would have the least impact on the natural environment. An estimated 9 fewer acres of soils, vegetation, and wildlife habitat would be disturbed. In addition, the 13-kV power line could be sited to avoid a linear configuration. Most of the problems discussed for the proposed arrangement--landslide instability, visual impact, and soil disturbance--would not exist.

Portal Arrangement Alternative 2

Portal arrangement alternative 2 would reduce the visual impact by eliminating most of the new road construction on the mountainside above the mine. Even so, only about three fewer acres would be disturbed overall. Visual impact would be only slightly less than the impact with the proposal, since the portals eliminated in alternative 2 are less visible than the lower portals. The 13-kV power line would have to be sited in a linear corridor to serve the Mountain View shaft site and the intermediate portals.

Alternative 2 would provide 35 additional construction jobs during the construction of an internal ramp made necessary by changing the portal arrangement. Construction of the ramp would require three years (Stillwater Mining Company, 1984a).

POWER ALTERNATIVES

Three power alternatives are being considered:

- Alternative 1: Big Timber to Nye power line.
- Alternative 2: Sheep Creek to Nye power line.
- Alternative 3: On-site power generation.

Stillwater Mining Company has not proposed a route for the 161-kilovolt power line. Montana Power Company is considering routes in the two corridors above, both starting from the Anaconda-Billings 161-kilovolt line.

Both corridors would have the Nye substation in common and would use the existing Benbow-Mouat 50-kilovolt line from the substation to the minesite. The Benbow-Mouat line would not be upgraded. The Montana Power Company (1984) has provided enough baseline information for a cursory examination of impacts. More information will be supplied to the Montana Department of Natural Resources and Conservation, which will publish an EIS that examines power-line impacts in detail.

V-4 / Power Alternatives

Construction of the power line would last about 7.5 months. Average employment would be 15 persons, with a peak of 25 and a minimum of 3 workers (Montana Power Company, 1984, p. 20). Maximum employment is expected to occur midway through the project. Job categories to be hired include equipment operators, linemen, groundmen, and foremen (Montana Power Company, 1984, p. 20).

Employment and income during construction of the power line would not be significant to the local economy. Due to the short construction schedule and crew size, impacts to community services and transportation would be insignificant. Availability of temporary housing could become strained if power-line construction goes on at the same time as other activities in the county such as oil and gas exploration and construction of the Stillwater Project.

The power line would provide additional property tax revenue to Stillwater County. The installed cost of the line would be \$90,000 per mile (1984 dollars) with an appraised value of \$7,500 per mile (Montana Power Company, 1984, p. 31). Total tax revenue generated would depend on local mill levies and the total value of the alternative route selected. The length of preliminary routes range from 40 to 46 miles (Montana Power Company, 1984, p. 22).

Power Corridor Alternative 1

In alternative 1, the transmission line would cross 9 perennial streams. Building of towers and roads could introduce sediment to these streams, but reasonable erosion-control methods could be implemented to minimize the impacts. The effect on aquatic organisms and fish would probably be undetectable. The sediment would be rapidly diluted, and the disturbance area would probably be small.

Detailed studies of each corridor will identify high hazard areas such as sites of mass wasting, avalanches, high wind, and water erosion. Such hazardous areas would be avoided or the hazard would be reduced by specific mitigation measures.

Soils information is now limited to erosion potential. When the exact route is chosen, Montana Power Company specialists will gather other soils data, including soil stability and revegetation potential. This more detailed information will then be submitted to the Department of Natural Resources and Conservation.

In alternative 1, the transmission route would cross about 7.2 miles of highly erosive soils. Most of these erosive areas are in natural ephemeral drainages. The topography and geomorphologic features would dictate construction equipment accessibility in these areas. Some erosion and subsequent sedimentation can be expected to occur, especially where temporary roads have to be bladed to allow equipment access. Assuming that reclamation would be concurrent with construction and no severe revegetation problems are encountered, impacts associated with soil erosion would probably be minimal.

The power line would have an 80-foot right-of-way, although the disturbance area would probably be much narrower. The vegetation of the power-line

route has not been mapped and revegetation plans have not been submitted. Vegetation disturbance and reclamation plans will be evaluated by the Department of Natural Resources and Conservation when Montana Power Company submits its studies.

Weed infestation along transmission corridors have been a problem in the past. In its application to the Department of Natural Resources and Conservation, Montana Power Company should propose measures to mitigate weed problems.

In alternative 1, the power line would cross mule deer and white-tailed deer winter ranges along the Yellowstone River and Bridger Creek. Although the disturbance area would probably be much narrower than the 80-foot right-of-way, deer would lose some habitat. Other deer may be displaced by the noise and activity of power-line construction. Similar effects on mule deer would be expected during construction across the Limestone winter range. Either substation would remove about 3 acres of white-tailed deer habitat near the Stillwater River.

The Yellowstone River is used as a migration corridor by waterfowl. Collisions with the power line would kill some waterfowl. Power-line poles would remove a small amount of wetland habitat. Collisions between waterfowl and power lines could be reduced by keeping lines below tree line, crossing the river diagonally, and using self-supporting poles (Thompson, 1978).

The power line could run within 1/4 mile of a historic peregrine falcon nesting site. If peregrines again occupy this site, power-line construction would create a potential for nest desertion.

Along the part of the route common to both alternatives 1 and 2, the power line would remove a small amount of deer habitat along the Stillwater River and construction may displace some deer. Upon entering the mine permit area, the power line would be within the Beartooth mule deer range. It would also be constructed along the northern edge of the bighorn winter range. Impacts on sheep and mule deer would be similar to those described in chapter IV, Wildlife.

In general, the design of most power-line pole types would probably prevent raptor electrocutions. Raptor protection would be assured if Montana Power Company would follow the design recommendations of Olendorff et al. (1981).

Depending on the centerline chosen, the power line in alternative 1 would be 40 to 46 miles long. In some cases, agricultural land for example, the right-of-way can be as small as 40 feet. The mileage of each land use crossed by the line is shown in table V-1.

Eleven cultural resource sites are located near the alternative 1 transmission line route. The six prehistoric sites consist of three stone ring sites, one stone cairn, one cave, and one stone breastwork site. The four historic sites are three homestead remains and a wagon road. Since the centerline location of the transmission line has not been determined, it is not known which of these 11 sites, if any, would be disturbed.

TABLE V-1

Average Miles of Land Use/Cover Crossed

	Irrigated Hay/Grain	Dry Grain	Dry Hay	Irrigated Sub- Irrigated Pasture	Forest ^a	Range
Big Timber Mine	0.8	0.6	0.8	2.2	4.0	34.8
Sheep Creek Mine	0	0.5	0.9	0.2	5.2	36.2

Source: Montana Power Company, 1984.

^aForest category includes coniferous, riparian, and rocky areas in southern part of study area.

The major visual change from the power line would probably be the new Nye substation. Up to three acres would be required for the substation construction. The substation would be visible to nearby residents and persons traveling FAS 419 and FAS 420 near Nye. Sections of the transmission line would also be visible in the foreground to travelers on Interstate 90, FAS 420, and FAS 419. The line would pass near subdivisions east of Big Timber and would probably be visible in the middleground and background.

Power Corridor Alternative 2

The transmission line in alternative 2 would cross 10 perennial streams. The effect on these streams, as in alternative 1, would probably be negligible.

The alternative 2 route would cross 5.8 miles of highly erosive soils, slightly less than in alternative 1. The problems that would result, as in alternative 1, would probably be minor. The impacts on vegetation, as in alternative 1, cannot be projected until Montana Power Company submits detailed studies to the Department of Natural Resources and Conservation. The problem of weed infestations would be the same in this alternative as in alternative 1.

This alternative would have impacts on wildlife similar to those in alternative 1. The same Yellowstone River deer winter range and waterfowl migration corridors would be crossed. Instead of crossing Bridger Creek deer range, this power line would travel through deer range along Countryman Creek. Mule deer in the Limestone winter range would lose some habitat and may be displaced during construction. More riparian deer habitat would be disturbed than on the other route. The power line would not be close enough to disturb any peregrine falcons that may start using the historic cliff site.

Depending on the exact location chosen, this alternative transmission route would be 42 to 44 miles long. The amount of cultivated land and pasture crossed would be less than in alternative 1 (table V-1).

In this alternative the power line would pass all but one of the cultural resource sites passed by the line in alternative 1. The one site not passed: the stone breastwork site.

In this alternative, the line would be slightly less visible than in alternative 1. Overall, however, the visual impact would be about the same.

On-site Generation--Alternative 3

The impacts to air quality of on-site power generation would be much greater than importing the electricity. The oil-fired power plant would emit about 24 tons of particulate, 293 tons of sulfur dioxide and 127 tons of nitrogen oxides annually (SMC, 1984). The addition of control devices would reduce the particulate and sulfur dioxide emissions substantially. Even with such control devices, the power plant would have a much larger effect on air quality than the mine and mill. (See Air Quality, chapter IV.)

The power plant would cause more noise than importing electricity. The generating facility would produce a noise level of 80 decibels (dB(A)) near the outside of the plant, even with the installation of noise attenuators (SMC, 1984). Assuming the 80 dB(A) level is measured at 10 feet from the plant, the noise level would decrease to 44 dB(A) at 640 feet from the plant (Loucks, 1973). At that distance the power-generating facility would add little, if any, to the noise from the milling operation.

The potential power-generating facility site has not been specified. However, the stack would probably be highly visible, with the building housing the turbines and generators being less visible, perhaps even hidden by the mill and tailing impoundment.

An on-site generator would disturb an additional 2 acres within the permit area. The site of the generator has not been specified; therefore, vegetation types and wildlife habitats affected cannot be identified. Revegetation methods and results would be similar to those described for the proposed mine. The generator would not noticeably increase impacts on wildlife above those resulting from the proposed mine.

WEST FORK OF THE STILLWATER ROAD ACCESSSES

There are two possible routes (fig. I-4) to reach the Forest Service trailhead on the West Fork of the Stillwater River:

- Proposal: via FR 846 (the existing route).
- Alternative: via a reconstructed abandoned road that links FR 140 and FR 846.

Proposed Access Route

The public using FR 846 to reach the trailhead on the West Fork of the Stillwater River could be inconvenienced by mine traffic. The inconvenience would probably be greatest during shift changes. The public could also be temporarily inconvenienced during mine construction and portal blasting, when FR 846

V-8 / West Fork of the Stillwater Road Accesses

would have to be periodically closed. The blasting and construction would result in a minor safety hazard to the public. Company traffic would introduce the potential for conflict with public traffic.

Stillwater Mining Company would build gates across roads that provide access to the mine portals and facilities. The 5,550-level portal would be the only portal next to FR 846. The yard for the portal would be secured with a fence and gate. No gate is proposed for the road serving the explosive storage. This could present security problems for the company and a risk to the public.

The proposal would allow the public to easily observe Stillwater Mining Company's mining and milling operation from FR 846.

Mitigating Measures

Stillwater Mining Company could install a gate on the road servicing the explosive storage area to control public access and improve security.

Picket Pin Road Alternative

Conflicts with public use and safety, although minor, would be eliminated by routing the public to the West Fork of the Stillwater River via FR 140 and a segment of reconstructed abandoned roadway. This alternative would, in addition, reduce views of the mine and reduce traffic through the bighorn range next to the minesite.

The reconstructed roadway would lie within the Picket Pin elk winter range. A minor amount of habitat would be lost, but would not affect the elk herd. Substantial traffic increases on the Picket Pin Road (FR 140) are not expected for December through mid-June. Therefore, impacts on wintering elk would not be significant.

The Forest Service estimates the Picket Pin Road alternative would increase traffic on FAS 420 and FR 140 near the historical peregrine falcon cliff complex by approximately eight cars per day from May through November. The additional traffic may effect potential peregrine falcon nest site selection (USDA, 1985).

Additional traffic on FR 140 may increase the county's road maintenance costs, but the amount would probably not be great. Maintenance costs would, for the most part, merely shift from FAS 419 to FR 140.

Forest users who use the Woodbine Campground as a drop point for trailers would have to travel a longer distance to reach the trailhead at the West Fork. The additional mileage would be about 9 miles. The Picket Pin alternative would provide less opportunities for the public to view the mining and milling operation.

Difficulty in acquiring private access could make this alternative impractical.

APPENDIXES

Tailing Pond Siting Study--Appendix A

Flotation Reagents Used in the Tailing Process--Appendix B

Crown Pillar Stability--Appendix C

Visual Resources System--Appendix D

Common and Scientific Names of Plant Species--Appendix E

Common and Scientific Names of Fish--Appendix F

Common and Scientific Names of Wildlife Species--Appendix G

APPENDIX A

Tailing Pond Siting Study

A preliminary review of aerial photos and topographic maps in the Stillwater project area reveals 18 possible sites for a tailing pond. (See table A-1 and fig. A-1.) To identify these sites, an interdisciplinary group of scientists and engineers noted depressions, hollows, draws, natural basins, and flat areas, especially where topography would help contain tailings and minimize the size of a tailing dam. The interdisciplinary group then evaluated the 18 sites to decide on the best.

TABLE A-1

Sites Considered

A Robinson Draw*	J Mine Site*
B Hertzler Ranch I*	K Beartooth Ranch*
C Hertzler Ranch II*	L Mountain View
D Hertzler Ranch III*	M Horseman Flats I
E Stanley Coulee*	N Horseman Flats II
F Prairie Creek*	O Cathedral Mountain
G Stratton Ranch*	P Buffalo Jump
H Limestone Cove	Q Ranch Creek
I Old Tailing Area*	R Horseman Flats III

*Sites also considered in MSME (1981) study.

The reason for the tailing site study was twofold: (1) to select feasible tailing pond sites that provide a range of alternatives to Stillwater Mining Company's proposal and (2) to check the findings of the Mountain State Mineral Enterprises (MSME) report commissioned by the Anaconda Minerals Company (AMC). The sites selected through this study are used as alternatives to Stillwater Mining Company's proposal. (See chapter I, II, and IV.)

In choosing the 18 sites for evaluation, no sites more than 7 miles from the mine were considered, because increasing the number of sites would not add alternatives with greater advantages. Likewise, no sites were identified inside the Absaroka-Beartooth Wilderness, because federal law would probably preclude such siting. In general, sites above 6,500 feet in elevation were not considered because in these areas successful tailing pond construction, operation, and reclamation would be hampered by high moisture, cold temperatures, steep terrain, and fragile soils and vegetation.

EVALUATION METHODS

The 18 sites were evaluated in two steps. In step 1, a "fatal flaw" stage, each site was subjected to four key tests. The sites failing any one (or

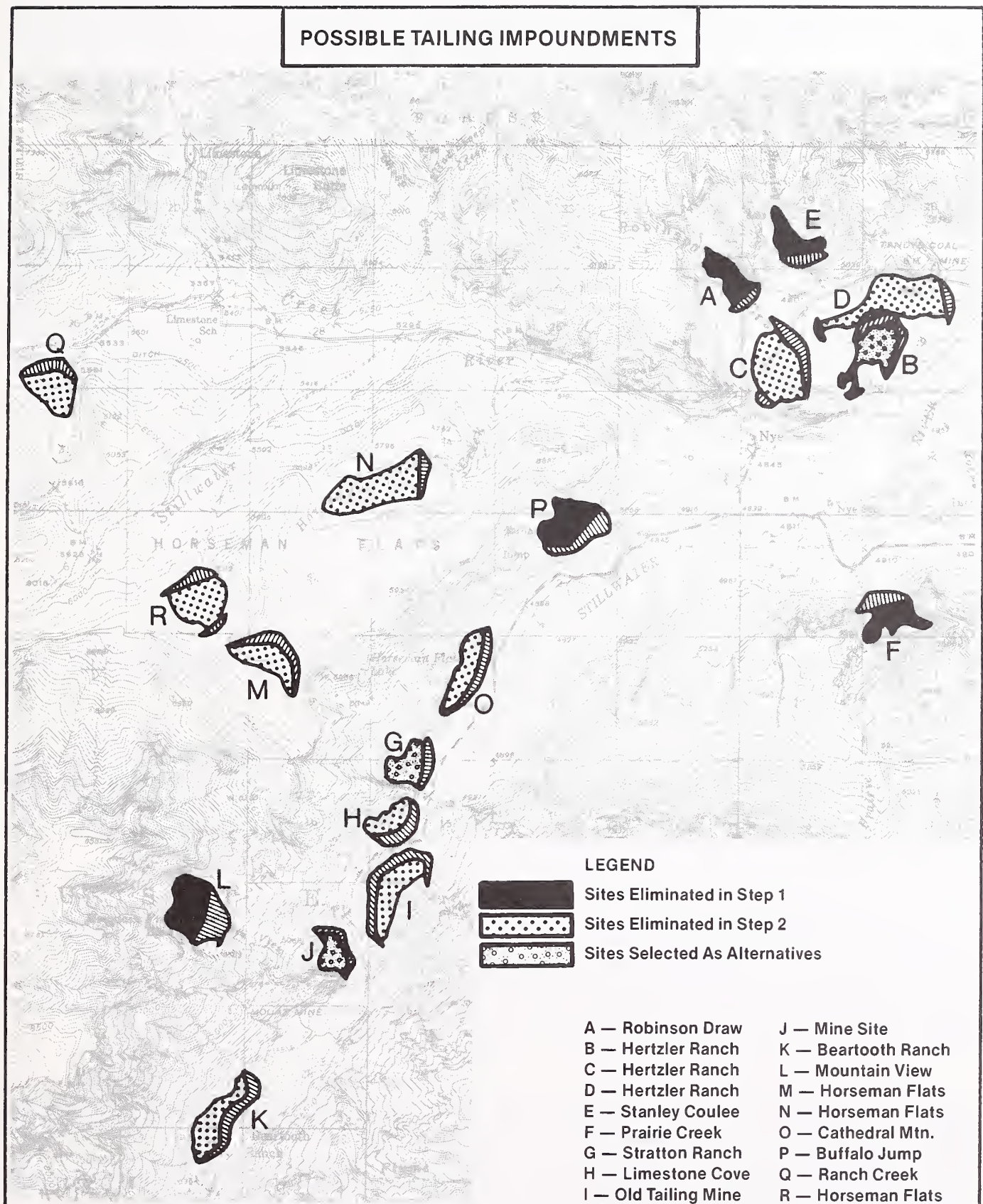


FIGURE A-1

The Department of State Lands and U.S. Forest Service evaluated 18 possible tailing sites. All but 3 sites were ruled out in a two-step selection process.

more) of the tests were ruled out as infeasible. In step 2, the feasible sites were rated. Four categories, each broken into parts, were used for the rating.

Step 1

The step 1 tests:

(1) Is the site outside wetlands? No impoundment can be built in wetlands, in accordance with Executive Order (from the President of the U.S.) 11990.

(2) Is the site outside floodplains? No site can be built where floods might cause breaching, piping, or overtopping, resulting in massive erosion during mining or after reclamation. No sites can be located on the 100-year floodplain of the West Fork or main stem of the Stillwater River per Executive Order 11988 and Montana's floodplain program.

(3) Is the site geologically stable? No site can be built where the geology would make long-term stability of the tailing dam, even with elaborate design, questionable.

(4) Would the site be in compliance with all laws? No site can be built where it would violate laws or regulations.

Of the 18 sites, five were eliminated in step 1: Robinson Draw (a), Stanley Coulee (E), Prairie Creek (F), Buffalo Jump (P), and Mountain View (L). (See fig. A-1.)

The wetlands test did not eliminate any site. At Beartooth Ranch (K), however, the impoundment would have to be confined to avoid wetlands. (See fig. A-1.) At Ranch Creek, the impoundment would contain a small wet area, but past grazing has eliminated the diverse ecosystem that made the site desirable and valuable as a wetland.

The floodplains test eliminated three sites: Robinson Draw (a), Stanley Coulee (E), and Prairie Creek (F). One-hundred-year floods could erode impoundments built at all three sites. The topography at these sites is steep, so diversion ditch grades would probably exceed 10 percent. Grass-lined channels should not exceed 10 percent on easily eroded material such as tailings (Haan and Barfield, 1979).

The geologic stability test eliminated two sites: Mountain View (L) and Buffalo Jump (P). Both sites lie on old landslides. Although the slides appear stable, it is unknown how much tailings they could support. Extensive geotechnical studies, outside the scope of this analysis, would be needed to determine the slides' load-carrying capacities. The Mountain View slide does appear able to withstand some mining (blasting, etc.) without movement being precipitated (Oriard, letter to Anaconda Minerals Company, July 14, 1982). Even so, without further studies, and with stable areas nearby, it is prudent to avoid the Buffalo Jump and Mountain View sites.

The legal test did not eliminate any sites. At Ranch Creek, however, county zoning would require majority consent of adjacent landowners before a nonconforming use, such as a tailing pond, could be approved.

Step 2

For each of the 13 remaining sites, engineers computed the likely impoundment configuration: dam height and volume, pond capacity, and area occupied. It was assumed that each site would hold at least 7 million tons of tailings. The configuration data were used to evaluate the impact that could stem from each site. The 13 sites were then rated using the following categories:

(1) Reclamation potential: (a) How much sandy loam (or finer) soil is available? (b) How high would the quality of postmining soil be? (c) How favorable is the aspect and landform position?

(2) Geologic stability: (a) How much would the impoundment load or remove support from potentially unstable areas? (b) How much subsurface drainage control would be required to maintain stability? (c) How large would the affected unstable area be? (d) How much bedrock geology is present that might promote instability? (e) How adverse are soil characteristics that could destabilize the impoundment?

(3) Runoff Design and Geomorphic Stability: (1) Would 100-year flooding of tributaries during dam life erode the dam? (b) How stable would the 100-year flood routing be after reclamation? (c) Would the impoundment and dam be geomorphically stable in the long term?

(4) Wildlife: How severe would the impacts be on (a) threatened and endangered species; (b) winter range; (c) calving/lambing/fawning habitats; and (d) travel lanes?

(5) Land acquisition: How difficult would it be to acquire (a) the slurry line right-of-way and (b) the tailing pond site?

The following ratings were used for each of the five categories:

0 = essentially no concerns

1 = minor concerns, easily mitigated

2 = moderate concerns, may require special design or mitigation measures

3 = major concerns, successful mitigation questionable

The results of step 2, as judged by the interdisciplinary group, are displayed in table A-2. To arrive at the table A-2 ratings, each question for each category was rated separately. The ratings were combined for the whole category into a composite value, shown in table A-2. The composite values were then totaled. (Note that table A-2 is a summary table. The full rating analysis, a lengthy and complex process, is described and documented in a report that is on file and available for review at the Department of State Lands, Helena, and the U.S. Forest Service, Billings and Red Lodge.)

TABLE A-2

Summary of Step 2: Final Ratings

Site	Ratings					Total
	Recla- mation	Geologic Stability	Runoff Design & Geomorphic Stability	Wild- life	Land Acquisition Consider- ations	
B Hertzler Ranch I	1	1	1	1	0	4
C Hertzler Ranch II	0	1	1	1	0	3
D Hertzler Ranch III	0	2	2	1	0	5
G Stratton Ranch	1	1	1	0	0	4
H Limestone Cove	1	1	1	0	3	7
I Old Tailing Area	2	2	2	2	0	8
J Mine Site	1	0	0	2	0	4
K Beartooth Ranch	1	2	2	3	0	7
M Horseman Flats I	0	1	1	2	2	6
N Horseman Flats II	0	2	2	3	3	10
O Cathedral Mountain	1	1	1	2	3	9
Q Ranch Creek	0	2	2	2	3	9
R Horseman Flats III	1	2	2	2	3	10

Below is a description of the main concerns at each site.

Sites B and C (Hertzler Ranch)

Total Score: 4 and 3, respectively.

Major Issues: Only minor concerns exist at these sites.

Site D (Hertzler Ranch)

Total Score: 5

Major Issues: Runoff Design. Control of surface water requiring a spillway during mining would pose a moderate problem. After reclamation, a 58-foot-wide, grass-lined diversion channel would have to be constructed across the reclaimed impoundment, requiring earth movement. The long-term stability of such a channel is questionable.

Site G (Stratton Ranch)

Total Score: 4

Major Issues: Geologic Stability. The site would probably require drainage measures, including a blanket drain in the dam, to prevent high ground water from destabilizing slopes. In addition, removal of unstable material or special impoundment design would be required, because about 25 to 35 percent of the site covers unstable landslide materials or potentially unstable slopes with soils that have fair to poor resistance to stress.

Site H (Limestone Cove)

Total Score: 7

Major Issues: Geologic Stability. The site would probably require a blanket drain and perhaps additional dewatering measures because of instability caused by high ground water conditions. About 25 to 40 percent of the area has unstable or potentially unstable slopes, or soils with low strength.

Land acquisition. Stillwater Mining Company would have to acquire private, subdivided land for the pond site. The acquisition might require condemnation.

Site I (The Old Chrome Tailing Site)

Total Score: 8

Major Issues: Reclamation. Rehabilitating the site without bringing in soil from another site would be difficult. More than 75 percent of the area, previously disturbed, lacks original soils. Existing materials have low water- and nutrient-holding capacities.

Water Quality and Geologic Stability. The site is close to the Stillwater River and probably has a high ground water table. This would probably demand special drainage measures to prevent impoundment destabilization. The area covers old tailings that may have a low resistance to stress.

Site J (The Minesite)

Total Score: 4

Major Issues: Only minor concerns associated with selection criteria.

Site K (Beartooth Ranch)

Total Score: 7

Major Issues: Geologic Stability. High ground water conditions, which may cause instability, would probably require drainage measures.

Wildlife. The impoundment would cause significant loss of bighorn sheep winter range.

Site M (Horseman Flats I)

Total Score: 6

Major Issues: Geologic Stability. The site lies close to a large mass waste scar and over shale bedrock with low mechanical strength and permeability. These conditions would complicate dam construction.

Wildlife. The site would cover elk winter range, disrupt an elk calving area, and displace elk, possibly reducing the elk population.

Site N (Horseman Flats II)

Total Score: 10

Major Issues: Geologic Stability. a 45-foot-wide diversion channel to divert the tributary to Horseman Creek around the pond would be required.

Wildlife. The site would cover elk winter range and calving grounds.

Site O (Cathedral Mountain)

Total Score: 9

Major Issues: Geologic Stability. The dam and pond would abut landslide materials and soils with poor resistance to stress. High ground water conditions, evidenced by small ponds and springs on the slide, would aggravate instability.

Land Acquisition. Acquisition would be difficult, because the site covers private, subdivided land, owned by many people.

Site Q (Ranch Creek)

Total Score: 9

Major Issues: Geologic Stability. The southwest part of the site covers shale bedrock that dips into the site. Soils under the dam area have poor resistance to stress. Possibly high ground water conditions may aggravate the soil instability problems.

Wildlife. Impacts on elk habitat would be similar to those at sites M and N.

Land Acquisition. Acquisition for the tailing pond would violate county zoning regulations.

Site R (Horseman Flats III)

Total Score: 10

Major Issues: Geologic Stability. A moderate amount of earthwork would probably be required to develop a 10-foot-wide grass-lined diversion ditch across the reclaimed impoundment. Heavy flooding could destabilize the channel leading to erosional downcutting.

Wildlife. Impacts on elk would be similar to impacts at sites M, N, and Q.

CONCLUSIONS

Sites rated 5 or less--B, C, D, G, and J--are considered acceptable. Sites C and D were eliminated from further consideration because they were similar to site B and offer no distinct advantages. Also, both sites C and D cover productive hayfields which site B does not.

Two sites were thus selected for alternative tailing disposal:

- B (Hertzler Ranch)
- G (Stratton Ranch)

APPENDIX B

Flotation Reagents Used in Milling Process

Summary of Potential Impacts: After the milling reagents in the tailing slurry leave the mill, they would enter the tailing pond. Based on the following information, the mill reagents would not be expected to present a significant environmental hazard: (1) the expected concentrations of these reagents that would reach the tailing pond would be low, (2) the general toxicity of reagents is low, even at the concentrations that would reach the tailing impoundment, and (3) the amount of tailing water seeping into the ground water would be very small in comparison to the total amount of ground water flowing through the valley.

The Flotation Process

The chemicals Stillwater Mining Company plans to use in the mill flotation process are copper sulfate, potassium amyl xanthate, carboxy methyl cellulose, polypropylene glycol methyl ether, and sulfuric acid. Once the exact milling process is decided on, the company may make some minor changes in the chemicals used; however, the chemicals used would probably be similar in chemical composition to the ones discussed here.

The froth flotation process that Stillwater Mining Company proposes to use is a physical-chemical method of separating and concentrating the metals in finely ground ores. In the process, the crushed ore is mixed with chemicals in a water solution to create conditions favorable for the attachment of desired minerals to air bubbles. The air bubbles carry the minerals--sulfide minerals in this case--to the surface of a slurry pulp. A froth containing the minerals forms at the surface of the slurry and is skimmed off while the other constituents in the ore rock remain submerged (Dow Chemical Company, 1976, p. 2). The froth is then dewatered and sent to a refining plant--Stillwater Mining Company has not yet specified where--for processing to extract platinum-group and other precious metals. The pulp slurry left at the bottom of the flotation cells is piped to the tailing pond for disposal. The froth flotation process would recover over 90 percent of the precious metals from the original ore.

The Function of the Reagents in the Flotation Process

Potassium Amyl Xanthate. This compound is an anionic flotation collector used for sulfide mineral ores. The collector is the most important chemical in the flotation process, since it is the reagent that produces a film on sulfide mineral particles and causes the particles to attach firmly to the rising air bubbles.

Carboxy Methyl Cellulose. This compound is used as a dispersant and to protect certain mineral surfaces against the action of other flotation agents.

This compound helps settle out unwanted tailings, such as clays, which tend to reduce the effectiveness of the flotation process. It also reduces the consumption of the xanthate collector.

Polypropylene Glycol Methyl Ether. This compound is a frothing agent that is used to give a temporary toughness and elasticity to the air bubbles used to float the desirable minerals to the surface. It also lowers the surface tension of the water, much the same way a household detergent works. All the frothers presently in use are organic heteropolar compounds (Dow Chemical Company, 1976, p. 9).

Copper Sulfate. This copper salt is a resurfacing cationic agent that attaches to the metallic minerals such as nickel, cobalt, iron, and zinc sulfide. The copper sulfate cause the metals to attach to the rising air bubbles. Without it, they would not readily attach.

Sulfuric Acid. A dilute solution of sulfuric acid would be used to adjust the pH of the mill slurry.

Concentration of Flotation Reagents in the Tailing Pond

Reagent concentrations in the tailing pond are summarized in table B-1.

TABLE B-1

Estimated Concentrations of Reagents in the Tailing Pond

Reagent	Dosage (lbs/ton processed)	Efficiency ¹ Factor (%)	ppm in Tailing Solids	ppm in Tailing Water ²
Polyglycol Ether	0.06	4-9	0	1.3-2.6
Xanthate	0.09	20-25	6.8-9	0.96
Copper Sulfate (Hydrated)	0.017	20-25	1.3-1.7	0.2
Cellulose	0.56	100	258-263	5-7.4
Sulfuric Acid (Sulfate)	0.43	100	0	(90)

¹Percent of reagent "wasted" to tailing pond.

²For every ton of tailings milled, 2.333 tons of water would be added diluting reagent concentrations by that amount.

Toxic Potential of the Flotation Reagents

From the estimated concentration of reagents in the tailing pond water (table B-1) the reagent concentration in receiving waters can be calculated.

Assuming five percent of the tailing pond would be unlined, approximately 10 gpm (gallons per minute) would enter the Stillwater River alluvial ground

water. (Ten gpm is a high estimate for the amount of seepage from punctures and leaky seams.) If the entire liner were to fail (an extreme case), the maximum seepage rate would be about 200 gpm at all sites except Hertzler Valley. There, seepage would be about 100 gpm because of underlying geologic conditions.

Polypropylene Glycol Methyl Ether. The ground water of the Stillwater River near the mine would contain at most several parts per million (ppm) polyglycol ether beneath the pond. Mixing of seepage water with ground water would lower concentrations to much less than 1 ppm within several hundred feet of the mine. Even if the pond were to completely fail (extreme case) concentrations within one mile of the mine would fall to less than 1 ppm. Laboratory tests on rats indicate this compound is only moderately toxic. The acute oral toxicity level (50 percent mortality) is 3,300 mg/kg (ppm), several orders of magnitude greater than the concentrations that would occur in the pond water, (Dow Chemical USA, 1976, Materials Safety Sheet).

Assuming complete mixing in the Stillwater River concentrations of polyglycol ether would be diluted to several parts per billion (ppb). Results of fish toxicological studies indicate that for freshwater fish acute toxicity levels (LD 50) are greater than 1,000 ppm (Parrish, 1976).

Potassium Amyl Xanthate. The concentration of xanthate in the tailing pond water is estimated to be about 1 ppm. Mixing in the ground water would dilute this to less than 0.1 ppm within several hundred feet of the mine. Acute oral toxicity to laboratory rats (LD 50) is greater than 1,000 mg/kg or ppm (Dow Chemical USA, 1976, Materials Safety Sheet).

Further dilution of seepage water in the Stillwater River would drop xanthate levels to probably less than 1 ppb (parts per billion), even during low flow. In a 28-day test, xanthate was found to be nontoxic to rainbow trout at a concentration of 1.0 ppm (Webb, Ruber, and Ledue, 1976). For daphnia magna, a crustacean, concentrations ranging from 0.1 to 1.0 ppm were found to be toxic (Parrish, 1976). Even if the pond were completely unlined, xanthate concentrations in the river would be one tenth of the lowest toxic level reported for the sensitive Daphnia.

The same general conditions would apply to locating the pond at the Stratton Ranch or Hertzler Valley sites.

Copper Sulfate. Stillwater Mining Company estimates that about 0.017 lbs/ton copper sulfate would be used in the milling process. At that rate 15 to 20 percent would end up in the tailings as insoluble solids and about 5 percent or 0.05 ppm would remain in the tailing liquid. Copper concentrations in the ground water with some mixing would drop to less than 0.004 ppm, safe for domestic (1 mg/l) and agricultural purposes (0.2 mg/l, Montana Ground Water Class I).

In the Stillwater River, copper concentrations would increase by less than 0.05 ppb as long the liner held up and by less than 1 ppb if maximum possible seepage were to occur (an extremely unlikely case). Concentrations of total recoverable copper in the Stillwater River above the West Fork naturally range from less than 2 to 17 ppb (Montana Fish, Wildlife, and Parks,

1977). Based on the average hardness in the river of about 20 mg/l (CaCO_3), long-term toxicity may occur in sensitive aquatic life at concentrations as low as 4.4 ppb (U.S. Environmental Protection Agency, 1980).

The mine-induced loading of the Stillwater River would be extremely small and changes could not be detected. The river now appears to be at or above the threshold at which long-term copper toxicity affects may occur and would remain so with or without the mine.

Carboxy Methyl Cellulose. The company proposes to use 0.56 pounds of cellulose for every ton of ore processed. Most of this would report to the tailing pond bound to sediment. The estimated concentration of cellulose in the water would be 3.6 to 4.8 ppm. Dilution would lower this to less than 1 ppm in the ground water near the mine and less than 0.01 ppm in the river. This compound is used as a food additive in such products as ice cream and diet foods. It is considered to be "relatively harmless."

Sulfuric Acid (Sulfate). The company estimates that the maximum usage rate of sulfuric acid (H_2SO_4) would be about 0.43 lb/ton to achieve an optimum process water pH of 8.1.² At this usage rate and pH, the tailing pond water would contain about 90 ppm sulfate (SO_4). At these levels, neither the pH nor the sulfates would harm human or aquatic life. Dilution of sulfate in the ground water would lower sulfate concentrations to less than 10 ppm. Sulfate concentrations on the river are normally very low, ranging from 5 to 15 ppm (mg/l).

APPENDIX C

Crown Pillar Stability

Summary: Stillwater Mining Company (SMC) proposes to leave a minimum 20-foot-thick crown pillar (undisturbed cap of ore rock) above the underground excavations. Tests of ore strength indicate that over the 20-year life of the mine the crown pillar might be stable and safe for mine workers. But because the pillar is highly jointed (fractured) and the ore rock is susceptible to weathering, the pillar could eventually collapse. This might expose the underground excavation to the surface, posing a slight public safety hazard. Backfilling of all underground workings is one way to minimize surface subsidence that would result from crown pillar collapse.

Strength Tests

SMC has determined, using computer simulations, that destabilizing stresses developing in a 20-foot-thick crown pillar with 60 feet of unconsolidated material on top would average 220 pounds per square inch (psi) and reach a maximum of 500 psi. At 500 psi, the stresses would be less than one tenth of the strength of the solid ore rock (5,900 psi).

These rock strength simulations, however, did not take into account factors such as jointing that reduce the strength of the crown pillar. Using a method described by Bieniaski (in Lama and Vutukuri, 1978), SMC's figures can be adjusted to account for the following strength factors: (1) rock quality (percentage of rock core samples that are hard and sound), (2) spacing of joints, (3) condition of joints, and (4) ground water inflow. The average compressive strength of the crown pillar, incorporating these strength reduction factors, could be as low as 1,000 psi, a 6-fold decrease from the initial compressive calculation of 5,900 psi. (Note: Other methods of determining rock strength have been developed, but the specific information needed to use them was unavailable.)

The safety factor (actual rock compressive strength divided by crown pillar stress [1,000 psi/220 psi]) would therefore probably be about 4 and could be as low as 2 (1,000 psi/500 psi) in the high stress areas of the crown pillar. For underground excavations, a safety factor of 2 to 4 is widely accepted (Ed Van Eechhout, Montana College of Mineral Science and Technology, oral com., March 29, 1983). Recent research indicates a safety factor of 1.5 to 2 is probably sufficient (Peng, 1978, p. 188). The crown pillar would therefore be stable enough to prevent collapse and assure miner safety during the life of the mine.

However, in extreme circumstances, rusting of rock bolts, rotting of timbers, and weathering of the crown pillar over hundreds or more years could cause parts of the crown pillar to collapse.

The breakdown of minerals along joints and fractures would eventually weaken the rock. Pieces of rock could gradually crumble and fall from the lower side of the pillar. The pillar could over time become thinner and thinner from the bottom side up. Stresses within the crown pillar would gradually shift upward, perpetuating periodic caving of the pillar until the entire pillar disintegrated.

Should the pillar collapse, the unconsolidated surficial material above the pillar would fall into the uppermost mine stope, thereby exposing the underground excavations to the surface. The exposed cavity could be up to 20 feet wide, several hundred feet long and about 150 feet deep if the sill pillar holds. Any surface expression of this kind would follow the trend of the proposed surface adits and could take several hundred to thousands of years to develop, although there is a low probability that it could occur in a shorter time period.

Another scenario is that because of the greater stresses at depth, spalling of the hanging wall and footwall would occur over time so that the spalled rock fragments would fill the gap between the walls. This could fill the stopes, stabilize the walls, and prevent further collapse. If the failure occurred in this fashion, the subsidence could occur over a long period and over a large surface area, resulting in a gradual, even lowering of the overall surface.

Crown Pillar Collapse

How long it would take for the crown pillar to fail is unknown, because the thickness of crown pillar material left would vary (with a minimum thickness of 20 feet) and the rate of rock weathering would be variable. Subsidence would never be continuous over the entire length of the underground workings. Five 40-foot-wide vertical support pillars would be left within the 4,800-foot section being mined. Moreover, unconsolidated deposits (weathered bedrock, colluvium, and glacial debris) resting on top of the crown pillar and excavated ore zone would likely ravel into and, in places, fill the hole. Where the depth of unconsolidated deposits reach more than 50 feet (assuming a 60° angle of repose) and the excavation is not over 200 feet deep (one stope height), no surface subsidence or collapse might occur.

Because the area between the Minneapolis adit and the head frame area is relatively remote and used little for recreation, the danger posed by such cavities would be low.

Mitigating Measures

1. Delineating a 20-foot-thick section of competent ore rock

SMC may have difficulty maintaining a 20-foot-thick section of competent (stable) ore rock. The biggest problem would be delineating the point dividing unweathered from weathered ore rock. If the contact between competent bedrock and the overlying material is sharp--a possibility if glaciers have scraped off the semi-weathered bedrock--a geophysical (seismic reflection) survey

could delineate the top of the competent bedrock. Such geophysical surveys used in conjunction with core samples would help SMC maintain the necessary 20 feet of crown pillar.

If, on the other hand, the top of the bedrock (ore zone) gradually changes from solid to highly weathered rock, delineating 20 feet for the crown pillar would be difficult, if not impossible. Underground miners generally judge from experience when to stop mining upward. Despite the value of experience, maintaining a 20-foot-thick crown pillar would be difficult for the miners to determine without extensive drill cores or geophysical information.

2. Remedial action after the crown pillar fails

Fencing of the property would reduce the hazard posed by a cavity created from crown pillar collapse, but fences require routine maintenance and do not discourage trespass by the curious. The gap could be spanned by concrete, but because concrete decomposes over time, the solution is not permanent.

3. Backfilling mine stopes before the mine is abandoned

Filling the mine stopes with mill tailings or waste rock would minimize surface subsidence. However, the stopes could not be completely filled and the material used for fill would settle, leaving some space at the top of the stope, into which the crown pillar could settle. Even so, backfilling could eliminate subsidence of the surface; crown pillar, rocks, and overlying unconsolidated deposits would expand in volume upon falling into the hole, compensating for the partial void left on top of the backfilled material.

APPENDIX D

Visual Resources System

Existing Visual Condition

Existing Visual Condition (EVC) is the present state of visual alteration measured in degrees of deviation from the natural landscape (table D-1). To estimate the effects of each Stillwater Project alternative, the predicted future visual condition of the landscape of each alternative must be compared with the existing visual condition.

Visual Absorption Capability

The inherent ability of the landscape to absorb alterations is the visual absorption capability. Land features such as soil type, topography, and vegetative regeneration potential are evaluated to rank the land into high, moderate, or low absorption capability.

Visual Quality Objectives

Landscape management objectives based on the physical and sociological characteristics of an area are visual quality objectives. The objectives refer to the degree of acceptable alteration of the characteristic landscape.

Preservation (P): Ecological changes only, except for very low visual impact recreation facilities.

Retention (R): In general, man's activities cannot evident to the casual forest visitor.

Partial Retention (PR): In general, man's activities may be evident, but must remain subordinate to the characteristic landscape.

Modification (M): Man's activity may dominate the characteristic landscape, but must at the same time utilize naturally established form, line, color, and texture. It should appear as a natural occurrence when viewed in middle ground or background.

The visual management system which establishes these VQOs is defined in National Forest Landscape Management, vol. 2, chapter 1, The Visual Management System, USDA Handbook 462.

TABLE D-1

Existing Visual Condition Definitions

CLASS		DEFINITION
EVC 1	Untouched:	Areas of $\pm$ 5,000 acres in which only ecological changes have taken place, except for low impact rails and fences.
EVC 2	Unnoticed:	Changes in the landscape are not visually evident to the average person unless pointed out. This also includes low visual impact 2-track trails and roads that may or may not be visible on most aerial photos.
EVC 3	Minor Disturbance:	Changes in the landscape are noticed by the average person, but they do not attract attention. The natural appearance of the landscape still remains dominant. This includes developed pastures and roads and fields not associated with farmsteads.
EVC 4	Disturbed:	Changes in the landscape are easily noticed by the average person and may attract attention. This includes cropland or highly developed hayfields (structural irrigation and canals). Well-designed oil fields are most always included, since their size and influence over the landscape is not entirely mitigable. The natural appearance of the landscape is definitely impacted in fields with well spacing at 160 acres or less.
EVC 5	Major Disturbance:	Changes in the landscape are major and would be obvious to anyone. These changes stand out as a dominating impression of the landscape. Oil fields that are not designed or have no mitigating measures as well as other activities that have major landscape impacts are included.
EVC 6	Drastic Disturbance:	Changes in the landscape are in glaring contrast to the natural appearance. Almost anyone would be displeased with the effect and agree that rehabilitation is required.

APPENDIX E

Common and Scientific Names of Plant Species

Common Name	Scientific Name
Grasses and grasslike	
Idaho fescue	<u>Festuca idanhoensis</u>
Needle-and-thread	<u>Stipa comata</u>
Blue grama	<u>Bouteloua gracilis</u>
Little bluestem	<u>Schizachyrium scoparium</u>
Western wheatgrass	<u>Agropyron smithii</u>
Bluegrass	<u>Poa spp.</u>
Japanese brome	<u>Bromus japonicus</u>
Bluebunch wheatgrass	<u>Agropyron spicatum</u>
Cheatgrass	<u>Bromus tectorum</u>
Meadow fescue	<u>Festuca pratensis</u>
Redtop	<u>Agrostis alba</u>
Intermediate wheatgrass	<u>Agropyron intermedium</u>
Timothy	<u>Phleum pratensis</u>
Orchard grass	<u>Dactylis glomerata</u>
Brome grass	<u>Bromus spp.</u>
Sun sedge	<u>Carex heliophila</u>
Needleleaf sedge	<u>Carex stenophylla</u>
Beaked sedge	<u>Carex rostrata</u>
Tule bulrush	<u>Scirpus acutus</u>
Spikesedge	<u>Eleocharis macrostachya</u>
Prairie sandreed	<u>Calamovilfa longifolia</u>
Beardless wheatgrass	<u>Agropyron inerme</u>
Sheep fescue	<u>Festuca ovina</u>
Canada bluegrass	<u>Poa compressa</u>
Green needlegrass	<u>Stipa viridula</u>
Creeping foxtail	<u>Alopecurus arundinaceus</u>
Forbs	
Silvery lupine	<u>Lupinus argenteus</u>
Blazing star	<u>Liatris punctata</u>
Hood's phlox	<u>Phlox hoodii</u>
Rock salaginella	<u>Salaginella densa</u>
Silky lupine	<u>Lupinus sericeus</u>
Slimflower scurfpea	<u>Psoralea tenuiflora</u>
Common dandelion	<u>Taraxacum officinale</u>
Red clover	<u>Trifolium pratense</u>
Field mint	<u>Mentha arvensis</u>
Cutleaf coneflower	<u>Rudbeckia lacinata</u>
Cow parsnip	<u>Heracleum sphondylium</u>
Meadow aster	<u>Aster conspicuus</u>
Wartberry fairybells	<u>Disporum trachycarpum</u>
Arrowleaf balsamroot	<u>Balsamorhiza sagittata</u>

APPENDIX E

Common and Scientific Names of Plant Species
(continued)

Common Name	Scientific Name
Forbs (cont.)	
Spreading dogbane	<u>Apocynum androsaemifolium</u>
Field chickweed	<u>Cerastium arvense</u>
Loose-flowered milkvetch	<u>Astragalus tenellus</u>
White spiraea	<u>Spiraea betulifolia</u>
Alfalfa	<u>Medicago sativa</u>
Yellow sweetclover	<u>Melilotus officinalis</u>
Black medic	<u>Medicago lupulina</u>
Purple prairie clover	<u>Petalostemon purpureum</u>
Silky lupine	<u>Lupinus sericeus</u>
Fringed sagewort	<u>Artemisia frigida</u>
Shrubs and trees	
Big sagebrush	<u>Artemisia tridentata</u>
Skunkbush sumac	<u>Rhus trilobata</u>
Black cottonwood	<u>Populus trichocarpa</u>
Balsam poplar	<u>Populus balsamifera</u>
Quaking aspen	<u>Populus tremuloides</u>
Willow	<u>Salix</u> spp.
Alder	<u>Alnus</u> spp.
Birch	<u>Betula</u> spp.
Common chokecherry	<u>Prunus virginiana</u>
Red-osier dogwood	<u>Cornus stolonifera</u>
Whortleleaf snowberry	<u>Symphoricarpos oreophilus</u>
Wood's rose	<u>Rosa woodsii</u>
Rocky Mountain maple	<u>Acer glabrum</u>
Mountain ninebark	<u>Physocarpus monogynus</u>
Creeping juniper	<u>Juniperus horizontalis</u>
Douglas fir	<u>Pseudotsuga menziesii</u>
Limber pine	<u>Pinus flexilis</u>
Ponderosa pine	<u>Pinus ponderosa</u>
Lodgepole pine	<u>Pinus contorta</u>
Common juniper	<u>Juniperus communis</u>
Kinnikinnick	<u>Arctostaphylos uva-ursi</u>
Subalpine fir	<u>Abies lasiocarpa</u>
Engelmann spruce	<u>Picea engelmannii</u>
Huckleberry	<u>Vaccinium</u> spp.

APPENDIX F

Common and Scientific Names of Fish

<u>Common Name</u>	<u>Scientific Name</u>
Brown trout	<u>Salmo trutta</u> .
Rainbow trout	<u>Salmo gairdneri</u>
Brook trout	<u>Salvelinus fontinalis</u>
Cutthroat trout	<u>Salmo clarki</u>
Mountain whitefish	<u>Prosopium williamsoni</u>
Longnose sucker	<u>Catostomus catostomus</u>
Mountain sucker	<u>Catostomus platyrhynchus</u>
Longnose dace	<u>Rhinichthys cataractae</u>
White sucker	<u>Catostomus commersoni</u>
Mottled sculpin	<u>Cottus bairdi</u>
Shorthead redhorse	<u>Moxostoma breviceps</u>

APPENDIX G

Common and Scientific Names of Wildlife Species

Common Name	Scientific Name
Mammals	
Elk	<u>Cervus canadensis</u>
Mule deer	<u>Odocoileus hemionus</u>
Bighorn sheep	<u>Ovis canadensis</u>
Dall's Sheep	<u>Ovis dalli</u>
White-tailed deer	<u>Odocoileus virginianus</u>
Black bear	<u>Ursus americanus</u>
Moose	<u>Alces alces</u>
Mountain goat	<u>Oreamnus americanus</u>
Mountain lion	<u>Felis concolor</u>
Deer mouse	<u>Peromyscus maniculatus</u>
Gapper's red-backed vole	<u>Clethrionomys gapperi</u>
Long-tailed vole	<u>Microtus longicaudus</u>
Yellow-pine chipmunk	<u>Eutamias amoenus</u>
Water vole	<u>Arvicola richardsoni</u>
Least chipmunk	<u>Eutamias minimus</u>
Bushy-tailed woodrat	<u>Neotoma cinerea</u>
Beaver	<u>Castor canadensis</u>
Muskrat	<u>Ondatra zibethica</u>
Porcupine	<u>Erethizon dorsatum</u>
Cottontail	<u>Sylvilagus sp.</u>
Snowshoe hare	<u>Lepus americanus</u>
White-tailed jackrabbit	<u>Lepus townsendii</u>
Raccoon	<u>Procyon lotor</u>
Long-tailed weasel	<u>Mustela frenata</u>
Mink	<u>Mustela vison</u>
Striped skunk	<u>Mephitis mephitis</u>
Coyote	<u>Canis latrans</u>
Bobcat	<u>Lynx rufus</u>
Birds	
Peregrine falcon	<u>Falco peregrinus</u>
Bald eagle	<u>Haliaeetus leucocephalus</u>
Golden eagle	<u>Aquila chrysaetos</u>
Northern harrier	<u>Circus cyaneus</u>
Red-tailed hawk	<u>Buteo jamaicensis</u>
American kestrel	<u>Falco sparverius</u>
Rough-legged hawk	<u>Buteo lagopus</u>
Prairie falcon	<u>Falco mexicanus</u>
Western meadowlark	<u>Sturnella neglecta</u>
Vesper sparrow	<u>Poocetes gramineus</u>
Mourning dove	<u>Zenaida macroura</u>
Blue grouse	<u>Dendragapus obscurus</u>
Ruffed grouse	<u>Bonasa umbellus</u>
Gray partridge	<u>Perdix perdix</u>

APPENDIX G

Common and Scientific Names of Wildlife Species
(continued)

Common Name	Scientific Name
Mallard	<u>Anas platyrhynchos</u>
Mountain chickadee	<u>Parus gambeli</u>
Evening grossbeak	<u>Hesperiphona vespertina</u>
Reptiles and Amphibians	
Red-sided garter snake	<u>Thamnophis sirtalis</u>
Wandering garter snake	<u>Thamnophis elegans</u>
Yellow-bellied racer	<u>Coluber constrictor</u>
Prairie rattlesnake	<u>Crotalus viridis</u>
Bullsnake	<u>Pituophis melanoleucus</u>
Rocky Mountain rubber boa	<u>Charina bottae</u>
Leopard frog	<u>Rana pipiens</u>

LITERATURE CITED

- Allen, E. B., and M. F. Allen. 1980. Natural reestablishment of vesicular-arbuscular mycorrhizae following stripmine reclamation in Wyoming. *Journal of Applied Ecology* 17:139-147.
- Allen, M. F. 1984. Physiology of mycorrhizae: a key to understanding successful plant establishment. In: *VA Mycorrhizae and Reclamation of Arid and Semiarid Lands*, eds. S. E. Williams and M. F. Allen. University of Wyoming, Agricultural Experiment Station, Laramie. pp. 69-80.
- American Fisheries Society. 1979. A review of the EPA Red Book--Quality criteria for water. R. V. Thurston et al., eds. Bethesda, Maryland: Water Quality Section of American Fisheries Society.
- Anaconda Minerals Company. 1980. Application for operating permit: Stillwater platinum-palladium project in Stillwater County, Montana. Denver, Colorado: Anaconda Minerals Company.
- Andryk, T. A. 1983. Ecology of bighorn sheep in relation to oil and gas development along the east slope of the Rocky Mountains, northcentral Montana. M.S. thesis, Montana State University, Bozeman, Montana. 100 pages.
- Beak Consultants Incorporated. 1982. Land use, recreation, and aesthetics, Technical Report no. 15. Portland, Oregon.
- Bear, G. D. 1979. Evaluation of bighorn transplants in two Colorado localities. Fort Collins, Colorado: Colorado Division of Wildlife Special Report 45.
- Berg, W. A. 1974. Grasses and legumes for revegetation of disturbed subalpine areas. In: *Revegetation of high altitude disturbed lands*, eds. W. A. Berg et al., 31-35. Environmental Resource Center Information Series no. 10, Colorado State University, Fort Collins, Colorado.
- Bleistein, Sandra. 1978. World market study for important metals of the Stillwater Complex--Chromite, nickel-copper, platinum-palladium. Report prepared for the Beartooth Tri-County Planning Group, Columbus, Montana.
- Board of Public Education. [no date]. Standards of accreditation of Montana schools. Page 5.
- Botz, M. K. December 12, 1978. Letter to Dr. Loren Bahls of Montana Water Quality Bureau, Helena, Montana.
- Briscoe, Maphis, Murray, and Lamont, Inc. [BMML]. April 1982. Service and fiscal impact analyses on schools and public service systems: no action and proposed alternative. Draft report prepared for Anaconda Minerals Company. Boulder, Colorado. Prepared for Anaconda Minerals Company. 93 pages. On file at the Montana Department of State Lands, Helena, Montana.

VII-2 / Literature Cited

- Brown, R. W., R. S. Johnston, B. Z. Richardson, and E.E. Farmer. 1976. Rehabilitation of alpine disturbances: Beartooth Plateau, Montana. In: High Altitude Revegetation Workshop no. 2, eds. R. H. Zuck and L. F. Brown, 58-73. Fort Collins: Colorado State University.
- Brown, R. W., and R.S. Johnston. 1978. Rehabilitation of a high elevation mine disturbance. In: High Altitude Revegetation Workshop no. 3, ed. S. F. Kenny, 116-130. Colorado State University, Fort Collins.
- Call, M. 1979. Habitat management guides for birds of prey. U.S. Department of Interior, Bureau of Land Management Technical Note 338. 70 pages.
- Camp Dresser and McKee, Inc. [CDM]. 1981. Anaconda Stillwater project 12-month environmental baseline report, vol. 1 and 3. CDM Project no. 3139. Wheat Ridge, Colorado.
- Camp Dresser and McKee, Inc. 1984. Preliminary air quality modeling for the Stillwater Mining Project. Denver, Colorado.
- Carbaugh, B. et al. 1975. Distribution and activity of white-tailed deer along an interstate highway. Journal of Wildlife Management 39(3): 570-581.
- Casne and Associates. October 1984. Amended facility plan for Absarokee, Montana. Page 66.
- Chae, Yong S. 1978. Effects of blasting vibrations on structures and people. In: Proceedings of U.S. Symposium on Rock Mechanics, 19th ed., ed. Yung Sam King. Reno, Nevada: University of Nevada-Reno.
- Christensen, M., and M. F. Allen. 1980. Effect of VA mycorrhize on water stress tolerance and hormone balance in native western plant species. Final report submitted to the Industrial Fund of the Rocky Mountain Institute of Energy and Environment, College of Engineering, College of Arts and Sciences, University of Wyoming, Laramie.
- Conn, H. K. 1979. The Johns-Manville platinum-palladium prospect, Stillwater Complex, Montana, U.S.A. Canadian Mineralogist 17:463-468.
- Cordell, C. E., and D. H. Marx. 1983. The status and practical application of Pisolithus tinctorius ectomycorrhizae in forest tree nurseries, field forestation, and mine land reclamation--1983. Information paper, Southeastern Forest Experiment Station, Asheville, North Carolina. 3 pages.
- Cundell, A. M. 1977. The role of microorganisms in the revegetation of strip-mine lands in the western United States. Journal of Range Management 30:299-305.
- Davidson, D. E. 1976. Soil microflora and microfauna. I. Microfungi, mycorrhizal associations and decomposition. In: Final Environmental Assessment, Black Thunder Mine Site, Vol. 2, eds. Bergmand and Marcus. Wyoming Environmental Institute, University of Wyoming, Laramie, pp. VI-1 to VI-17.

- Doerr, T. B., E. F. Redente, and F. B. Reeves. 1984. Effects of soil disturbance on plant succession and levels of mycorrhizal fungi in a sagebrush-grassland community. *Journal of Range Management* 37(2): 135-139.
- Dow Chemical Company. 1976. Flotation fundamentals and mining chemicals. Midland, Michigan.
- Elred, K. M. 1974. Assessment of community noise. *Noise Control Engineering* 3(2): 88-95.
- Engineering and Mining Journal, December 1984. Markets. Page 25.
- Entercom. 1981. Stillwater county resident survey--tabular data and narrative analysis. Report prepared for Anaconda Minerals Company. Denver, Colorado. 1,008 pages. On file at the Montana Department of State Lands, Helena, Montana.
- Everett, R. L. 1980. Use of containerized shrubs for revegetating arid roadcuts. *Reclamation Review* 3:33-40.
- Federal Register. May 19, 1980. EP toxicity test procedure. 45(98): 33127-33129, appendix II.
- Fedkenheuer, A. W., H. M. Heacock, and D. L. Lewis. 1980. Early performance of native shrubs and trees planted on amended Athabasca oil sand tailings. *Reclamation Review* 3(1): 47-55.
- Ferguson, R. B., and N. C. Frischnecht. 1981. Shrub establishment on reconstructed soils in semiarid areas. In: *Proceedings of Symposium on Shrub Establishment on Arid and Semi-arid Lands*, 57-63. Laramie, Wyoming.
- Ferrier, G. J. 1974. Bighorn sheep along the lower Colorado River, 1974-2050. *Transactions of Desert Bighorn Council* 18:40-45.
- Finn, W. D. 1980. Seismic response of tailing dams. In: *Design and construction of tailing dams*, ed. David Wilson. Golden, Colorado: Colorado School of Mines Press.
- Fisser, H. G. 1981. Shrub establishment, dominance, and ecology on the juniper and sagebrush-grass types in Wyoming. In: *Proceedings of Symposium on Shrub Establishment on Disturbed Arid and Semi-arid Lands*, 23-28. Laramie, Wyoming.
- Fresquez, P.R., and W. C. Lindemann. 1982. Soil and rhizosphere microorganisms in amended coal mine spoils. *Soil Science Society of America Journal* 46:751-755.
- Geist, V. 1971a. Mountain sheep--a study in behavior and evolution. Chicago and London: University of Chicago Press. 383 pages.

VII-4 / Literature Cited

- . 1971b. A behavioral approach to the management of wild ungulates. In: Symposium of British Ecological Society 11:413-474.
- . 1982. On "population control" with reference to mountain sheep and goats. In: Proceedings of Biennial Symposium on Northern Wild Sheep and Goat Council 3:23-24. (Abstr.)
- Gerdemann, J. W. 1970. The significance of vesicular-arbuscular mycorrhize in plant nutrition. In: Root Diseases and Soil-Borne Pathogens, eds. T. A. Taussaun, R. V. Bega, and P. E. Nelson. Berkeley, California: University of California Press. pp. 125-129.
- HKM Associates. 1981. Feasibility study for the rehabilitation of FAS 419, Stillwater County, Montana. Prepared for Anaconda Minerals Company. Billings, Montana. 92 pages. On file at the Montana Department of State Lands, Helena, Montana.
- Hinshaw, Robert F., and Larry D. Prinkki. 1981. Landslide hazards--Anaconda Stillwater Complex Project, Nye, Montana. U.S. Department of Agriculture, Forest Service, Region 1, unpublished technical evaluation.
- Horejsi, B. 1976. Some thoughts and observations on harassment and bighorn sheep. In: Proceedings of Northern Wild Sheep Council, 149-155. Cheyenne, Wyoming.
- Housing Development Associates. 1984. Stillwater Mining Company Housing Needs Analysis Report prepared for Stillwater County. Billings, Montana. 40 pages.
- Howland, A. L., J. W. Peoples, and Edward Sampson. 1936. The Stillwater igneous complex and associated occurrences of nickel and platinum-group metals. Butte, Montana. Montana Bureau of Mines and Geology, miscellaneous contribution no 7.
- Hull, A. C., Jr. 1974. Species for seeding mountain rangelands in southeastern Idaho, northeastern Utah, and southern Wyoming. Journal of Range Management 27:150-153.
- Hydrometrics. 1981. Hydrological evaluation of a proposed exploration adit, Anaconda Copper Company, Stillwater Project, Nye, Montana. Helena, Montana, unpublished report.
- . 1984. Investigation of the use of percolation ponds for disposal of mine water, Stillwater Mining Company, Nye, Montana. Helena, Montana, unpublished report.
- Jackson, C. L. 1982. An update of Urad mine reclamation. In: Proceedings of High Altitude Revegetation Workshop, eds. Cuany and Etra, 79. Workshop no. 5, Colorado State University, Fort Collins, Colorado.

- Jackson, Everett, (1968) [reprint 1970]. The chromite deposits of the Stillwater Complex, Montana. In: Ore deposits of the U.S., 1933-1967 (Groton-Sales volume), Vol. 2, ed. John Redige, New York: American Institute of Mining Metallurgists and Petroleum Engineers. pp. 1495-1510.
- Jensen, I. B., and R. L. Hodder. 1979. Tubelings, condensation traps, mature tree transplanting and root sprigging techniques for tree and shrub establishment in semi-arid areas. Vol. 2. Montana Agricultural Experiment Station, Montana State University, Resource Report 141. 105 pages.
- Jones, W. R., J. W. Peoples, and A. L. Howland. 1960. Igneous and tectonic structures of the Stillwater Complex, Montana. U.S. Geological Survey Bulletin 1071-H, p. 281-340.
- Kay, B. L. 1980. Mulch choices for erosion control and plant establishment. Weeds, Trees, and Turf 19(8): 16-24.
- Kerin and Associates, Consulting Engineers. December 1984. Utility expansion plan. 42 pages.
- Klohn, E. J. 1980. The development of current tailings dam design and construction methods. In: Design and construction of tailings dams, 1981, ed. David Wilson. Golden, Colorado: Colorado School of Mines Press.
- Loma, R. D., and U. S. Vutu Kuri. 1978. Handbook on mechanical properties of rocks, Vol. IV. Clausthal, Germany: Trans Tech Publications.
- Larson, J. E. 1980. Revegetation equipment catalog. Vegetation rehabilitation and equipment workshop. USDA Forest Service, Missoula, Montana.
- Larson, J. E. 1980. Revegetation equipment catalog. USDA Forest Service Equipment Development Center, Missoula, Montana. U.S. Government Printing Office Stock no. 001-001-00518-5. 198 pages.
- Laycock, W. A. 1982. Seeding and fertilizing to improve high-elevation rangelands. USDA Forest Service, General Technical Report INT-120. 19 pages.
- Liberta, A. E. 1981. Effects of topsoil-storage duration on inoculum potential of vesicular-arbuscular mycorrhizae. Symposium on Surface Mining Hydrology, Sedimentology. Lexington, Kentucky: University of Kentucky. pp. 45-48.
- Lindemann, W. C., D. L. Lindsey, and P. R. Fresquez. 1984. Amendments of mine spoil to increase the number and activity of microorganisms. Soil Science Society of America Journal 48:574-578.
- Long, S. G. 1981. Characteristics of plants used in western reclamation. 2d ed. Fort Collins, Colorado: Environmental Research and Technology, Inc. 138 pages.

VII-6 / Literature Cited

- Loree, M. A. J., and S. E. Williams. 1984. Colonization of western wheatgrass (Agropyron smithii Rydb.) by vesicular-arbuscular mycorrhizal fungi during revegetation of a surface mine. In: VA Mycorrhizae and Reclamation of Arid and Semiarid Lands, eds. S. E. Williams and M. F. Allen, p. 82.. Laramie, Wyoming: University of Wyoming, Agricultural Experiment Station.
- Loucks, D. P. 1973. Environmental noise management. In: Models for Environmental Pollution Control, ed. R. A. Deininger, 377-399. Ann Arbor Science Publishers, Inc. Ann Arbor, Michigan.
- MacArthur, R. A., D. H. Johnston, and V. Geist. 1979. Factors influencing heart rate in free-ranging bighorn sheep: a physiological approach to the study of wildlife harassment. Canadian Journal of Zoology 57:2010-2021.
- MacArthur, R. A., V. Geist, and R. H. Johnston. 1982. Cardiac and behavioral responses of mountain sheep to human disturbance. Journal of Wildlife Management 46(2): 351-358.
- MacFadyen, Michael J. 1983. Phase out of coal mining in the Decker study area. Report prepared for Decker Area Mine Comprehensive Social Sciences Study, Montana Department of State Lands and U.S. Office of Surface Mining. Billings, Montana: Mountain West Research-North, Inc. 20 pages.
- MacMahon, J. A., and N. L. Warner. 1984. Dispersal of mycorrhizal fungi: processes and agents. In: VA Mycorrhizae and Reclamation of Arid and Semiarid Lands, eds. S. E. Williams and M. F. Allen, pp. 28-41. Laramie, Wyoming: University of Wyoming, Agricultural Experiment Station.
- Malloch, D. W., K. A. Pirozynski, and P.H. Raven. 1980. Ecological and evolutionary significance of mycorrhizal symbioses in vascular plants. Proceedings of the National Academy of Sciences [USA] 77:2113-2118.
- Marcuson, P. E., P. E. Foennis, and M. Schollenberger. 1982. Stillwater River fisheries investigations. Montana Department of Fish, Wildlife and Parks. 46 pages.
- Mautz, W. M. 1978. Nutrition and carrying capacity. In: Big Game of North America, eds. J. L. Schmidt and D. L. Gilbert, 321-348. Stackpole Books, Harrisburg, Pennsylvania.
- McKell, C. M. 1982. New developments in soil amendments--a biologist's point of view. In: Proceedings: High-altitude Revegetation Workshop no. 5, eds. R. L. Cuany and J. Etra, 151-163. Fort Collins, Colorado: Colorado State University Information series no. 48.
- Menge, J. A., and L. W. Timmer. 1982. Procedures for inoculation of plants with vesicular-arbuscular mycorrhizae in the laboratory, greenhouse, and field. In: Methods and Principles of Mycorrhizal Research, ed. N. C. Schenk, 59-68. St. Paul, Minnesota: The American Phytopathological Society.

Metals Week. February 11, 1985.

Mid-Yellowstone Areawide Planning and Organization. 1978. Other non-point source assessment (draft). Billings, Montana: U.S. Environmental Protection Agency, Section 208. Areawide waste treatment management grant.

Miller, J. F., R. H. Frederick, and R. J. Tracey. 1973. Precipitation-frequency atlas of the western United States. Vol. 1; Montana. Silver Springs, Maryland, U.S. Department of Commerce. 40 pages.

Miller, R. M., and R. E. Cameron. 1976. Some effects of soil microbiota of topsoil storage during surface mining. In: Fourth Symposium on Surface Mining Reclamation Conference and Exposition. II. pp. 184-200. Louisville, Kentucky.

Montana Department of State Lands and Kootenai National Forest. 1978. Draft environmental impact statement--Troy project, Asarco Inc., Vol. 1. Helena, Montana.

Montana Department of State Lands and U.S. Forest Service. 1982. Draft environmental impact statement, Anaconda Stillwater Project, Stillwater County, Montana.

----- . 1984. Tailing pond location study, Stillwater Mining Company's Stillwater Project. A technical support document prepared for the Stillwater Project environmental impact statement.

Montana Power Company. 1984. The Stillwater Mining Company 161 kV transmission line project. Report to Montana Department of State Lands.

Mosse, B., and D. S. Hayman. 1971. Plant growth responses to vesicular-arbuscular mycorrhiza. New Phytologist 70:29-34.

Mountain States Mineral Enterprises [MSME]. 1981. Alternate mill/tailing-pond site location study, phase I report. In: Preliminary engineering study: unpublished report to the Anaconda Minerals Company, on file at the Department of State Lands, Helena, Montana.

Naldrett, A. J., and J. M. Duke. 1980. Platinum metals in magmatic sulfide ores. Science, June 27, 1980, 203(4451).

National Research Council. 1977. Medical and biologic effects of environmental pollutants--platinum group metals. Washington, D.C.: National Academy of Sciences. 239 pages.

Olendorff, R. R., A.D. Miller, and R. N. Lehman. 1981. Suggested practices for raptor protection on powerlines: The state-of-the-art in 1981. Raptor Research Foundation, Raptor Research Report no. 4. 109 pages.

Oriard, L. L. 1982. Letter to Stephen Dole regarding blasting effects on potential slope failures, on-file report, Custer National Forest, Billings, Montana.

VII-8 / Literature Cited

- Overton, W. S. 1971. Estimating the numbers of animals in wildlife populations. In: Wildlife Management Techniques, ed. R. H. Giles, 403-455. Washington, D.C.: The Wildlife Society. 633 pages.
- Parkinson, D. 1978. Microbes, mycorrhizae and mine spoil. In: Ecology and Coal Resource Development, Vol. 2, ed. M. K. Wali, 634-642. New York: Pergamon Press.
- Parrish, L. P. 1976. Environmental Protection Agency letter to Abe Horpsted of Montana Department of Health and Environmental Sciences, on file at Montana Department of State Lands, Helena, Montana.
- Peng, Sid. 1978. Coal mine ground control. New York: Wiley and Sons. 449 pages.
- Penrose, K. D., and D. J. Hansen. 1981. Planting techniques for establishment of container-grown or bare-root plants. In: Proceedings of Symposium on Shrub Establishment on Arid and Semi-arid Lands, 37-46. Laramie, Wyoming.
- Perry, C., and R. Overly. 1977. Impact of roads on big game distribution in portions of the Blue Mountains of Washington, 1972-1973. Applied Research Bulletin no. 11. Olympia, Washington: Washington State Game Department. 38 pages.
- Pfister, R. D., B. L. Kovalichik, S. F. Arno, and R. D. Presby. 1977. Forest habitat types of Montana. U.S. Department of Agricultural, U.S. Forest Service, General Technical Report INT-34.
- Qamor, Anthony, and Ray Breuninger. 1979. Earthquake hazard to the proposed Northern Tier Pipeline in Montana. In: report no. 4 of the Northern Tier Pipeline Environmental Impact Statement. Helena, Montana: Montana Department of Natural Resources and Conservation.
- Raedeke, Linda. 1979. Stratigraphy and petrology of the Stillwater Complex, Montana. Master thesis at University of Washington.
- Read, Ransom, R. 1977. Summary report--Mineral development potential of the Stillwater Complex, Montana. Spokane, Washington: Western Field Operations Center, U.S. Bureau of Mines.
- Reynolds, P. C. 1974. The effects of simulated compressor station sounds on Dall sheep using mineral licks in the Brooks Range, Alaska. Arctic Gas Biological Report Series, vol. 23. (Abstr.)
- Risenhoover, K. L., and J. A. Bailey. 1980. Visibility: an important factor for an indigenous, low-elevation bighorn herd in Colorado. In: Proceedings of Biennial Symposium of the Northern Wild Sheep and Goat Council 1980:18-28.
- Rives, C. S., M. I. Bajwa, A. E. Liberta, and R. M. Miller. 1980. Effects of topsoil storage during surface mining on the viability of VA mycorrhiza. Soil Science 129(4): 253-257.

- Rost, G. R., and J.A. Bailey. 1979. Distribution of mule deer and elk in relation to roads. *Journal of Wildlife Management* 43(3): 634-641.
- Russell, K. R. 1978. Mountain lion. In: *Big Game of North America*, eds. J. L. Schmidt and D. L. Gilbert, 207-225. Harrisburg, Pennsylvania: Stackpole Books.
- Schuman, G. E., E. M. Taylor, Jr., F. Rauzi, and G. S. Howard. 1980. Standing stubble versus crimped straw mulch for establishing grass on mined lands. *Journal of Soil and Water Conservation* 35(1): 25-27.
- Seed, H. Bolton, Faiz L. Makdisi, and Pedro DeAlbe. July 1978. Performance of earth dams during earthquakes. *Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers*, Vol. 104, no. GT7.
- Simmons, C., S. Stewart, and T. Butts. 1981. Big game survey and inventory, deer and elk. Region 5 Job Progress Report. Montana Department of Fish, Wildlife, and Parks, Helena, Montana. 121 pages.
- Singleton, P. C., and S. E. Williams. 1979. Effects of long-term storage on the fertility and biological activity of topsoil. Final report submitted to the Institute of Energy and Environment, University of Wyoming, Laramie. 36 pages.
- Skiba, G. F., and J. L. Schmidt. 1982. Inbreeding in bighorn sheep: a case study. In: *Proceedings of Biennial Symposium of Northern Wild Sheep and Goat Council* 3:43-53.
- Snow, C. 1973. Habitat management for unique or endangered species, Golden Eagle. U.S. Department of Interior, Bureau of Land Management Report no. 7, Denver, Colorado. 52 pages.
- Spalding, D. J., and J. N. Bone. 1969. The California bighorn sheep of the south Okanagan Valley, British Columbia. *British Columbia Fish and Wildlife Branch Wildlife Management Publication no. 3*. Vancouver, British Columbia. 45 pages.
- Stemp, R. 1982. Heart rate responses of bighorn sheep to some environmental factors. In: *Proceedings of Biennial Northern Wild Sheep and Goat Council* 3:314-319.
- Stevens, D. R. 1982. Bighorn sheep management in Rocky Mountain National Park. In: *Proceedings of Biennial Northern Wild Sheep and Goat Council* 3:244-253.
- Stewart, P. A. 1977. Beartooth-Absaroka wildlife-mining research. Fisheries. Federal Aid to Fish and Wildlife Restoration. Project FW-2-R-5. Montana Department of Fish and Game. 172 pages.
- Stewart, S. T. 1975. Ecology of the West Rosebud and Stillwater bighorn sheep herds, Beartooth Mountain, Montana. M.S. thesis, Montana State University, Bozeman. 130 pages.

VII-10 / Literature Cited

- Stewart, S. T. 1984. Bighorn sheep section of annual Pittman-Robertson report. Unpublished preliminary draft. Montana Department of Fish, Wildlife, and Parks, Helena. 9 pages.
- Stewart, S. T., and F. W. Butts. 1982. Horn growth as an index to levels of inbreeding in bighorn sheep. Proceedings of Biennial Symposium of Northern Wild Sheep and Goat Council, 3:68-82.
- Stillwater Mining Company. 1984a. Application for an operating permit/plan of operations. Nye, Montana.
- [and Stillwater County]. 1984b. Stillwater Mining Company Hard Rock Mining Impact Plan. July, 1984.
- [and Stillwater County]. 1984c. Stillwater Mining Company Hard Rock Mining Impact Plan. September, 1984.
- [and Stillwater County]. 1985. Stillwater Mining Company Hard Rock Mining Impact Plan. March, 1985.
- Stoeckeler, J. H., and P. E. Slabaugh. 1965. Conifer nursery practice in the prairie-plains. U.S. Department of Administration Agriculture Handbook 279. 93 pages.
- Stoneberg, R. P. 1977. Beartooth-Absaroka wildlife-mining research. Game. Federal Aid to Fish and Wildlife Restoration Project FW-2-R-5. Montana Department of Fish and Game. 156 pages.
- Stroud, R. H. 1967. Water quality criteria to protect aquatic life: a summary. In: A symposium on water quality criteria to protect aquatic life, ed. E. L. Cooper, American Fisheries Society Special Publication no. 4, 33-37.
- Thirumai, K., and D. P. Schlick. 1978. Mine safety and health system and challenges in rock mechanics. In: Proceedings of U.S. Symposium on Rock Mechanics, 19th, ed. Yung Som Kim. Reno: University of Nevada-Reno.
- Thompson, L. S. 1978. Transmission line wire strikes: mitigation through engineering design and habitat modification. In: Proceedings of Workshop on Impacts of Transmission Lines on Birds in Flight, eds. M. L. Avery and K. D. Hoover, 27-146. U.S. Fish and Wildlife Service Publication FWS/OBS-78/48.
- Trappe, J. M. 1981. Mycorrhizae and productivity of arid and semiarid rangelands. In: Advances in food producing systems for arid and semiarid lands, 581-599. New York: Academic Press, Inc.
- U.S. Department of Agriculture. 1951. Soil Survey Manual. Agriculture Handbook no. 18. 503 pages.
- U.S. Department of Agriculture, Forest Service. 1974. National forest landscape management, Vol. 2. In: Agriculture Handbook 462.

- . 1982. Biological Assessment: Anaconda Stillwater Project. Report by Ronald Escane for Custer National Forest.
- . 1984. Biological Assessment: Stillwater Mining Company Project. Report by John Edwards for Custer National Forest.
- . 1985. Biological Assessment: Stillwater Mining Company Project. Report by John Edwards for Custer National Forest.
- U.S. Environmental Protection Agency. 1980. Water quality criteria documents availability. Federal Register 45(231), November 28, 1980.
- . 1975. Inactive and abandoned underground mining--Water pollution prevention and control. Office of Water and Hazardous Materials.
- U.S. Fish and Wildlife Service. 1984. Endangered and threatened wildlife and plants. 50 CFR 17.11 and 17.12. U.S. Fish and Wildlife Service, U.S. Department of the Interior. Washington, DC. 24 pages.
- U.S. Soil Conservation Service. 1981. Technical range site descriptions. Bozeman: Montana. U.S. Soil Conservation Service, U.S. Department of Agriculture.
- Ward, A. L. 1976. Elk behavior in relation to timber harvest operations and traffic on the Medicine Bow Range in south-central Wyoming. In: Proceedings of Symposium on Elk, Logging, Roads. 1976:32-43. Moscow.
- Webb, M, H. Ruber and G. Luduc. 1976. The toxicity of various mining flotation reagents to rainbow trout (Salmo Gairdnerii), Water Research, 10:303-306, Great Britain: Pergamon Press.
- Wetkind, Irving, J. 1975. Preliminary map showing known and suspected active faults in Western Montana: U.S. Geologic Survey open-file report, p. 75-285.
- Wimmler, N. L. 1948. Investigation of chromite deposits of the Stillwater Complex, Stillwater and Sweetgrass Counties, Montana. U.S. Bureau of Mines, report on investigations 4368, p. 41.
- Wittwer, R. F., S. B. Carpenter, and D. H. Graves. 1980. Effects of hardwood bark, wood fiber and straw mulches on temperature and moisture content of mine spoils. In: Symposium on Surface Mining Hydrology, Sedimentology and Reclamation, 193-197. Lexington, Kentucky.
- Wood, T. 1984. Commercialization of VA mycorrhizal inoculum: the reclamation market. In: VA Mycorrhizae and Reclamation of Arid and Semiarid Lands, eds. S. E. Williams and M. F. Allen, 21-27. Laramie, Wyoming: University of Wyoming, Agricultural Experiment Station.
- Youmans, H. B., S. T. Stewart, and A. R. Dood. 1982. Upper Stillwater big game technical report. Helena, Montana: Montana Department of Fish, Wildlife, and Parks. 98 pages.

CONSULTATION
AND
COORDINATION

RESEARCH AND WRITING

The following people prepared the EIS:

Carole Armstrong, Office Manager

Chuck Baer, Graphic Artist

- B.A. Art Education, Montana State University, 1970

Michael Beckes, Archaeologist

- Ph.D. Archaeology, University of Pittsburgh, 1977

Bill Birchard, Editor

- B.A. Biology, Colorado College, 1976

Michael Burnside, Geologist

- M.S. Geology, University of Montana, 1975

Ronald Escano, Wildlife Biologist

- B.S. Ecology, Humboldt State University, 1969

John Gibson, Supervisory Forester

- B.S. Forestry, Montana State University, 1963

John Herrin, Geologist/Hydrologist

- B.S. Earth Science, California State University, Long Beach, 1974

- B.S. Geology, Northern Arizona University, 1975

John Inman, Resource Coordinator

- B.S. Forestry, University of Montana, 1962

Phillip Jaquith, District Ranger, Beartooth Ranger District

- B.S. Forestry, Colorado State University, 1958

Scott McCollough, Wildlife Biologist

- B.S. Wildlife Biology, Colorado State University, 1977

- M.S. Wildlife Biology, Colorado State University, 1982

Robert Newman, Locatable Minerals Specialist

- B.S. Geological Engineering (Mining Option), Montana School of Mines,
1962.

Bill Olsen, Air Quality Specialist

- B.A. Biology, State University College of New York, 1971

- Ph.D. Botany, University of Montana, 1983

VIII-2 / Research and Writing

George Schaller, Supervisory Forester

- B.S. Forestry, University of Missouri, 1957

Jim Shell, Forester

- B.S. Forestry, Colorado State University, 1970

Scott Spano, Soil Scientist

- B.S. Forestry, Michigan Technological University, Houghton, 1976
- M.S. Forest Soils, Michigan Technological University, 1978

Lois Steinbeck, Economist

- B.S. Economics, Colorado State University, 1977

Kit Walther, Project Chief

- B.S. Zoology, University of Montana, 1966
- M.S.T. Biological Sciences, University of Montana, 1971

Sue Zike Koch, Landscape Architect

- B.S. Landscape Architecture, Iowa State University, 1974

The Department of State Lands and the U.S. Forest Service appreciate the assistance of Stillwater Mining Company, which provided information on the proposed mine.

REVIEW

The following people from the Department of State Lands reviewed this document:

Gary Amestoy, Reclamation Division Administrator
Dan Ashenberg, Hydrologist
Terry Grotbo, Hard Rock Bureau Chief
Gary Lynch, Range Scientist
John North, Legal Counsel
...add Forest Service personnel

PEOPLE, AGENCIES, AND COMPANIES CONSULTED

The following agencies and companies (other than those cited in the text) provided information used to analyze Stillwater Mining Company's mine plan:

Government Agencies

Montana State Board of Education, Helena (State Historic Preservation Program)

Montana Department of Administration, Research and Statistical Services
(Helena)

Montana Department of Commerce, Economic and Community Development Division
(Helena)

Montana Department of Commerce, Hard Rock Mining Assistance Board (Helena)

Montana Department of Fish, Wildlife, and Parks (Helena)

Montana Department of Health and Environmental Sciences, Air Quality Bureau
and Water Quality Bureau (Helena).

Montana Department of Justice, Highway Traffic Safety Section (Helena)

Montana Department of Highways, Planning and Research Bureau (Helena)

Stillwater County Planning Office (Columbus)

Sweetgrass County Planning Office (Big Timber)

U.S. Army Corps of Engineers

U.S. Department of the Interior, Bureau of Mines, Minerals Availability Field
Office (Denver, Colorado)

Nongovernment

Sandra Bleistein, Industrial Economics Division, Denver Research Institute
(Denver, Colorado)

Gene Braun, Transmission Engineering Section, Montana Power Company (Butte)

Jim Falvey, Montana Power Company, Butte

Northern Plains Resource Council (Billings)

REVIEW OF THIS STATEMENT

In accordance with environmental law, copies of the draft EIS have been sent to the public for comments and suggestions. All comments will be carefully considered in the preparation of the final EIS. Comments on the draft EIS can be sent to Commissioner Dennis Hemmer, Montana Department of State Lands, Capitol Station, Helena, Montana 59620.

The draft EIS is available for review in the following places:

Montana Department of State Lands, 1625 11th Avenue, Helena, Montana.

Custer National Forest, Supervisors Office, 2602 1st Avenue North,
Billings, Montana.

Custer National Forest, Beartooth Ranger District, Red Lodge Ranger
Station, Red Lodge, Montana.

VIII-4 / Review

Parmley Billings Public Library, 510 North Broadway, Billings, Montana.

Stillwater County Library, 400 3rd Avenue North, Columbus, Montana.

A limited number of copies are available on request from the Department of State Lands, Capitol Station, Helena, Montana 59620 and the U.S. Forest Service, P.O. Box 2556, Billings, Montana 59103.

